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PSYCHOLOGY FOR STUDENTS OF EDUCATION

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BY

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Revised Edition

New York
THE MACMILLAN COMPANY
1930

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Published May, 1923. Reprinted September, October, 1923; February,
June, September, 1924; January, May, October, 1925; April,
1926, January, 1927; March, 1928; May, 1929.
Revised Edition, April, 1930.

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SET UP AND ELECTROTYPED BY T. MOREY & SON

PRINTED IN THE UNITED STATES OF AMERICA

TO

G. S. G.

PREFACE

Rapid progress in the psychological study of problems in education has taken place since this book was first written in 1922. Many new fields have been explored and many theories, in good repute in 1922, have lost prestige as the result of scientific investigations. In this revision much new material is therefore included and many familiar theories have been discarded or revised.

In writing the revision the author has profited immensely from the suggestion of many instructors who have used the earlier edition extensively. He has also been guided by the suggestions contained in careful studies of the professional interests and needs of students of education made by G. B. Watson, O. E. Hertzberg, G. H. Hilliard, M. E. Haggerty, W. Perry, M. E. MacDonald, W. E. Peik and others. The author has tried to put into effect the recommendations most frequently made by these instructors and investigators.

New discoveries in educational psychology and additional information concerning the needs of students have led to changes so extensive as to require rewriting of the entire book. Some of the major changes may be briefly indicated. Certain topics have been given less space in the revision than in the original book. The treatment of the receiving, connecting, and reacting mechanisms now occupies one chapter instead of three as formerly. The new account is designed entirely to clarify certain psychological principles and not to induce the reader to study the mechanisms for their own sake. It is a much less detailed and technical account. The old chapter on classification of mental processes has been omitted entirely. Certain statistical and technical details concerning individual differences have been omitted. Indeed, all along the line materials which were of academic interest rather than of professional value have been eliminated.

Among the important additions the following may be noted: The space devoted to personality adjustment and development has been increased greatly. Not only are two chapters given over completely to this topic but nearly every other chapter has been rewritten to contribute much more than before to understanding of the problems. The topics of motivation and readiness are given more than twice as much space as before. The problem of heredity and environment is developed more specifically and extensively. Utilizing the recent researches of Baldwin, Gesell, and others, the treatment of growth of structures, functions, and forms of behavior has been expanded from one to two chapters. The processes of generalizing, reasoning, and imagining and the principles of guidance in learning have been treated with greater fullness. The nature and significance of interests and purposes, which were given scanty treatment in the first edition, have been offered proper attention in the revision. The chapter on transfer of training presents a new interpretation of the facts and a more detailed account of the implications. The treatment of adjusting the educative process to individual differences has been expanded. The chapter on ability and capacity is almost wholly new. More questions and exercises, and longer lists of references have been included.

The most significant change of all appears as the result of a three-fold purpose which the author has endeavored to keep foremost in mind in rewriting each section. These three purposes have been: first, to include only those materials which have practical, professional value to the student of education; second, to make the account as meaningful and non-technical as possible; and third, to show the student the applications and values of the principles by offering concrete illustrations and detailed applications to the problems of the school instead of merely stating the principles and leaving application to the reader. In short, a conscientious effort has been made to make the revision an intelligible presentation of professionalized subject matter.

One result of attempting to achieve a more intelligible and professionalized account has been an increase in the length of the book. The abundant use of concrete illustrations, applications, individual case studies, and discussions of school matters is chiefly responsible for the increased bulk of the volume. The major additions of material are the result of an effort to increase the interest, intelligibility, and professional usefulness of the book.

It is regretted that the list of names of instructors who have generously supplied the author with suggestions for the revision is too long to make feasible any attempt to thank them here individually. Since many persons using the book may wish to consult the studies that were such useful guides in writing the revision, some of the titles are here given. G. B. Watson, "What Shall Be Taught in Educational Psychology," *Journal of Educational Psychology*, Dec. 1926; O. E. Hertzberg, "The Opinion of a Teacher-Training Institution Concerning the Relative Value of Subject Matter in Educational Psychology," *Journal of Educational Psychology*, May 1928; M. L. Fisher (working under direction of W. Perry), "Vocabulary Difficulties of Students in Educational Psychology," *University of Nebraska Educational Research Record*, Oct. 1929; M. E. MacDonald, "A Catalogue Study of Courses," *Journal of Educational Administration and Supervision*, April, 1927; G. H. Hilliard, "Present Objectives in Educational Psychology," mimeographed report published by the Western State Teachers College, Kalamazoo, Mich., 1929; M. E. Haggerty, *A Check List of Topics in Psychology*, University of Minnesota, 1929; W. E. Peik, *An Analysis and Evaluation of the Prescribed Courses in Education*, manuscript in Library of University of Minnesota.

Acknowledgment to authors and publishers for permission to use illustrations and quotations are given in the text.

ARTHUR I. GATES

NEW YORK,
March, 1930.

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PSYCHOLOGY FOR STUDENTS OF EDUCATION

PSYCHOLOGY FOR STUDENTS OF EDUCATION

CHAPTER I

THE METHODS AND SUBJECT MATTER OF PSYCHOLOGY

Psychology is the study of a large number of problems concerning human behavior. Almost as far back as history is recorded, these problems have engaged the attention of thoughtful men. Teachers, priests and medicine men in ancient times attempted to understand, as best they could, the important characteristics of human conduct. Modern teachers, lawyers, preachers and business men attempt to solve substantially the same problems. Indeed, all of us, by reflecting upon our own impulses, feelings, ideas and acts and by observing the behavior of other people, develop opinions concerning the motives that make men willing to buy or fight or study, that arouse confidence or suspicion, that assuage anger, embarrassment or fear. Most of us have acquired beliefs concerning what the "mind" is and how it works, concerning the causes of bad judgment and prejudice, and the means of improving memory or will. We have explanations, too, of the nature and function of the emotions, of the value of clear mental images and the power of suggestion. We have ideas, too, about the magnitude of the differences in ability to learn among school children, whether such differences are inborn or due to training, illness or other removable factors. We have adopted methods—which are usually only vaguely understood—of judging traits of body, mind and character, such as quickness, endurance, alertness, sensitiveness, sagacity, honesty, ambitiousness and sociability. Most of us have notions concerning the typical relations of these traits, such as the belief that the brightest children are usually sickly or that the persons pronouncedly "fair" of skin and hair are likely to be "fickle and false." We have theories concerning the mental and temperamental differences between children and adults, men and women, Chinese and Negroes. We have acquired convictions concerning the effects of rewards and punishments, of alcohol and coffee, of indigestion and the weather upon efficiency. For a long time the subject of study by crude and inexact methods, these topics, together with many similar ones, when attacked by *scientific methods* constitute psychology, or to be more accurate, human psychology, since the scientific method can also be applied to animal behavior.

The essential feature of modern psychology, which differentiates it from older studies of human nature, is the method—the scientific method. To understand what psychology is, then, we must know the characteristics of the scientific method.

Characteristics of Scientific Investigations

The Scientific Method Seeks to Determine the Reliability of Observation.—The scientific investigator, like any other person, must secure his facts by observing the activities of himself or others. He seeks, however, to secure reliable reports. He strives also to detect the amount and kind of errors in all observations before they are used. That ordinary observations of things and events are usually far from reliable has been demonstrated in many tests. For example, a brief scene involving a quarrel which had been carefully rehearsed was performed before a group of forty professional men. Believing the quarrel to be genuine and anticipating the use of their testimony in court, the witnesses immediately wrote out a full account. Thirteen of the forty observers failed to record as much as half of the important events and the others omitted from one-fifth to a half of them. Even in these apparently conservative reports, from five to fifty per cent of the statements were erroneous.

Even when the surprise and possible emotional disturbances are eliminated by warnings and instruction and when the observers are aware of the amount and kinds of errors usually made in such tests, glaring omissions and errors occur. When the object of observation is a still picture, a mechanical device or even a postage stamp, the unreliability of ordinary observation is still apparent. It is, unfortunately, pronounced when the objects of observation are facial expressions or bodily attitudes, eye or hand movements—witness the ease with which sleight-of-hand performers deceive us—mental images and other activities important to psychology.

The Scientific Method Seeks to Increase the Reliability of Observation.—The unreliability of observation each of four causes: (1) inexperience of the observer; (2) anticipation or bias in the observer; (3) complexity and (4) brevity of the events being observed. The scientific worker attempts to improve conditions in all of these respects.

Training in Observation of Particular Events.—Inexperience, as a cause of incomplete and erroneous observation, suggests the need of training. That prolonged and controlled practice in observing a particular class of events does result in improvement is attested by results in many fields. Thus the trained musician hears fine variations in tone and harmony, the artist sees differences in color and perspective, the physician perceives symptoms of disease and health, the mariner detects signs of calm or storm, that are unobserved or inaccurately observed by the novice. Although nearly every one has observed the eyes of others during the act of reading, few persons have noticed with any precision the jerky, start and stop character of the movement of the eye as it follows the printed line. After a period of directed practice, one may learn to see these movements with considerable accuracy. Since practice will improve the accuracy and precision of observation along any line, the scientific method demands trained observers.

To be most effective, training in observation must be specific. The musician, by increasing his ability to perceive in the field of sound, becomes little if any more effective in observing colors, symptoms of disease or weather conditions. Thus for each science training must be specific; indeed, even within a single science, it must be specialized. The psychologist may become a proficient observer of the delicate eye movements without becoming a skilled observer of mental imagery or even of the facial expressions during emotions. The scientific method requires training in every type of observation in which reports are to be made.

Training Designed to Decrease Prejudice.—Anticipation of results, which often springs from prejudice or a desire to secure evidence favoring a cherished belief or theory, is a stumbling block in science as in everyday life. Just as most people are unable to observe evidence of guilt in a person loved, and as persons attending a spiritualist's séance so often mistake a hazy illumination for the face of a departed friend whose image has been in mind, so scientific workers are likely to be influenced by desire and expectation. Against these sources of error, the scientific worker must rigidly school himself. He must acquire the "scientific attitude," that is, an openminded, impersonal, unprejudiced attitude toward the facts observed. A few seem to be gifted with this attitude by nature, others acquire it only after prolonged and diligent effort. Provisions to secure unprejudiced observations are an important feature of the general methods of science.

Repeating an Observation to Increase Reliability.—Since observers, despite diligent training, are rarely absolutely accurate and sometimes misled by expectation or desire, the scientific method makes provision for repetition of observations. It is not sufficient that the investigator should repeat his own experiment, although this is desirable. Before the results of an observation are accepted, they must be repeated by others, usually many others. To this end, it is customary for the scientific worker to report in full, not only the results of his study, but also the conditions and procedures so that other investigators may set up an identical situation and repeat the observation. In this way, errors in observation, whether due to prejudice, oversight or other influences, may be detected. It will be observed that repetition of observations provides an opportunity for the investigator to check up his own work and thus learn to do it better. It also provides the means by which scientific repute, good or poor, may be established.

Securing Favorable Conditions for Observation.—Observation is misleading, it was said, not only because of inexperience and prejudice in the observer but also because of the complexity and brevity of many of the events to be observed. The repetition of observations by the same and different observers is one means of correcting errors due to the complexity and brevity of the events. Another means consists in arranging favorable conditions for observation. These conditions consist chiefly in the *isolation,* as far as possible of the fact to be observed and the control of all other factors. The character of the eye movements in reading, for example, may vary according to the length of the line, the difficulty of the material, the size of the type or the brightness of the illumination. Usually the subject, therefore, is seated in a room from which unusual light, sounds and other distractions are excluded. The material to be read, the distance of the eyes from the copy and all other factors which might affect the performance are controlled and reproduced when the experiment is repeated.

When the investigator is attempting to discover the causes and effects of an observed fact, it is especially important to isolate the fact and control all other factors. Thus, to ascertain the effect of the *difficulty* of reading material upon the character of the eye movements, it would be necessary to hold constant all other factors—length of the line, size of type, illumination, fatigue, etc. —while the difficulty of the material alone varied in repeated tests. In studying the effects of ventilation on mental efficiency, subjects were kept in a room in which temperature, movement of the air, humidity, the percentage of oxygen and the percentage of expired matter could be mechanically and independently varied. Under these conditions, the specific effects of temperature could be determined by securing samples of work under different degrees of heat, while other factors were held constant. Similarly the influence of humidity could be ascertained by varying it while all others factors are controlled.

Human subjects are played upon by so many forces and their adjustments to them are so subtle that extraordinary care must be exercised to secure adequate control of the conditions. A business-college teacher had developed a system of teaching handwriting. It was urged that this system was better than any other because most of the pupils became unusually good writers. But the truth was that the unusual amount of time and relentless insistence on achievement rather than the merits of the system were responsible for the pupils' success. Causes can be determined only when *all* of the influences are taken into account. The writing system must be tried by many different teachers on many different classes and the results compared with those obtained from trials of other systems, when the length of practice, the skill of teachers, the initial ability and interest of the pupils and other factors are equalized. Comparison of the school grades of students who smoke with the marks of non-smokers is usually of no scientific value for the same reason: we cannot tell whether the difference is due to smoking or to some one or more of many other factors such as differences between the groups in home surroundings, general intelligence, use of alcohol or other factors. In appraising any experiment reported, the important question to ask is: "*Did the experimenter control all of the factors save the one which is being studied?*" If he did not, the results are certain to be inconclusive.

Meaning of "Experiment."—When all of the conditions above described have been fulfilled, the procedure is usually called an *experiment* and the method, *experimental.* An experiment, then, is a study carried out by a trained worker who has isolated as well as possible the facts to be observed, brought all other variables under control and so completely arranged the procedure that it could be repeated exactly by himself or other investigators. An experiment differs from ordinary observation in that it is more carefully planned and executed, is more vigorous, systematic and open to verification by other persons.

The Use of Mechanical Devices to Improve Observation.—Even under the most carefully controlled conditions, the finest observers frequently secure results that are incomplete and erroneous. Many important events are intrinsically elusive or obscure. Much ingenuity has therefore been employed in the search for mechanical devices designed to supplement or supplant ordinary observation. The astronomer utilizing the telescope and the physiologist the microscope, are able to make observations more accurate and detailed than could be secured by the unaided eye. Especially sought are instruments which yield a permanent record that may be studied at any time by any person. Instead of the verbal report of an investigator concerning the facial expression of fear in an infant, it is better for scientific purposes to have a photographic record. Better than a report of the movement of the eyes in reading is a graphic record obtained by use of an apparatus invented for that purpose. Instead of estimating the pulse, respiration and glandular changes during excitement, it is better to use mechanical devices which yield tracings or records of chemical changes that may be preserved. Advances in psychology, as in other sciences, have resulted from the invention of instruments that have made observation more detailed, accurate and extensive.

The Use of Measuring Devices.—Of prime value are those instruments which make provision for a quantitative statement—a measurement. One can estimate roughly the heights of men, but for scientific purposes they must be measured with standard instruments under standardized conditions. One can estimate roughly the relative speed of muscular reactions, but with a delicate timing device they may be measured in thousandths of a second.

Some of the brightest pages in the history of psychology are those describing the development of measurements, and many inventions of measuring devices have made possible great progress in knowledge. The technique for measuring the frequency and duration of eye movements has been utilized in the study of a wide variety of problems in reading. The measurement of general mental ability has already led to researches that can scarcely be summarized in a single volume. The invention of means of measuring educational achievement was the forerunner of much of the scientific work in that field. Most human traits are unusually difficult to measure because of their complexity and because of the variations in performance from test to test. For some of the more complex human traits such as initiative, social sagacity, or persistence no very accurate measuring devices have as yet been developed and in proportion as these abilities cannot be measured, our knowledge of them remains inexact. Thus, in addition to isolation of the factors to be observed, in addition to control of all the significant influences and in addition to the provision for repetition of the whole procedure by trained observers, the scientific method ideally supplants, or supplements, ordinary observation by objective records, given whenever possible in the form of a quantitative statement or measurement of the facts.

The Use of Statistical Methods.—In most investigations of human behavior, another difficulty is encountered. Human subjects differ markedly from each other in their behavior and the same individual reacts differently at different times. Care must be exercised therefore to make sure that the results of an experiment are typical of the behavior of the particular subjects, and that the subjects adequately represent the whole class of people of which they are but samples. A single test of the speed of muscular contraction or a three-minute test of comprehension in reading is unlikely to yield a fair measure of an individual's ability. Perhaps it will require ten, twenty or fifty tests to secure a fair measure of the speed of muscular reaction or ten, twenty or fifty minutes of time to secure a fair measure of ability to comprehend in reading. Even if it had been determined, furthermore, by very thorough testing that a small number of children who comprehended very well were also very slow readers, it would be unsafe to generalize that *all* very slow readers have great power of comprehension. If we found in a particular sixth grade that the brightest children were all rather nervous the evidence would be insufficient to justify a declaration that bright children *in general* are nervous. If the boys in one school surpassed the girls in memorizing poetry, statements about the sexes as wholes should not be hastily made. If we desire to solve general problems—such as What is the relation of speed and depth of reading? What is the relation of intelligence and emotional stability? or what are the relative abilities of boys and girls in general?—we need more than a technique for handling individual experiments; we need statistical methods.

By means of statistical devices it is possible to ascertain how many times or for how long a time we must test an individual to secure a reliable measure of his reading or of any other ability. Similarly it is possible to determine how many individuals of a given age or sex must be tested to produce a measure fairly representative of the age or sex groups. In the event of an insufficient number of tests or individuals, it is possible to compute the magnitude of the error of the measures. This is but one of the statistical devices which form a part of the program for accuracy and precision characteristic of the scientific method.

Summary.—In order to increase the reliability, thoroughness and fullness of observation, the scientific method specifies the following as necessary or desirable.

(1) The investigator should be properly trained to observe the particular data of interest.

(2) The investigator should be able to avoid the influences of bias and expectation; he should be able to adopt a "scientific" or openminded attitude toward the facts to be observed.

(3) He should isolate as fully as possible the events to be observed.

(4) He should control all other factors that might conceivably influence the results.

(5) He should describe the setting and procedure so fully that he or other investigators may be able to repeat the investigation.

(6) He should employ those mechanical aids which increase the value of observation.

(7) He should secure graphic, photographic or other permanent records whenever possible so that others may study them later.

(8) He should state his results in quantitative terms whenever possible.

(9) He should subject his data to rigid statistical treatment.

(10) He should take careful account of the extensity or duration of the measurements and observations, the number and characteristics of the subjects so that others may apply statistical treatment to the results.

GENERALIZING FROM THE FACTS OBSERVED

Science Attempts to Explain Its Observed Facts.—Thus far, the discussion has been confined mainly to the errors of observation and the devices utilized to avoid or remove them. The accumulation of trustworthy observations or particular facts is but one phase of the work of science. Equally important and equally difficult is the interpretation of facts, the development of general laws and principles. When Benjamin Franklin flew his kite in a thunderstorm, he observed a phenomenon, an electric spark jumping from the cord. Verified on other occasions, it was recognized as a fact. When Franklin stated as a result of his observations that lightning was merely a huge electric spark, he had gone beyond the observable facts. He had developed an hypothesis. As it happened this hypothesis was borne out by later investigations and finally accepted as a general principle, a law or general truth.

An hypothesis is any conception by means of which some one goes beyond the facts and seeks to establish relations between data that have been observed. It is a conjecture, a guess, a provisional explanation; it is an interpretation or enlargement of what is observed. The development of hypotheses is one of the important features of scientific work. The ability to generalize or theorize has been the outstanding characteristic of most eminent men of science. Conjecturing, guessing, theorizing, is not confined to any one period of an investigation; it is usually incessantly active, preceding, accompanying, following and guiding all experimentation.

Differences in interpretation are usual. Everywhere are encountered rival hypotheses which must eventually be evaluated not only on the basis of further observations but also in the light of certain principles of guidance in interpretation. Just as there are checks, controls and accepted rules to guide observation, so there are devices for avoiding errors and reaching the most effective conclusions in thinking about facts collected. It is quite as difficult to think validly as to observe accurately. The scientific method, consequently, comprises a series of rules, all of the rules of logic and in addition certain others that are designed to guide the construction of hypotheses.

Science Favors the Hypothesis Which Has the Widest Application.—Other things being equal, science accepts the hypothesis which explains the most, which has the widest application. Psychology, for example, seeks a single formula by means of which to explain the mechanics of all behavior, both of body and mind, in normal and abnormal individuals, in animals as well as man. It favors one type of explanation for learning of all sorts, swimming, singing, control of anger, memorizing, solving geometry problems, rather than one set of hypotheses for acquiring muscular skills, another for modifying emotions and another for accumulating information. Rival hypotheses are being constantly tested by application to new particular facts as they appear. That hypothesis which explains, most adequately and widely, the known facts is the one most acceptable to science.

Science Favors the Simplest Explanation; the Law of Parsimony.—Of several rival hypotheses, equally good in other respects, science favors the one which affords the simplest explanation. In one form or another, this rule, which is known as the Law of Parsimony, has been accepted by all sciences. What shall be meant by simplicity must be determined by each science for itself. In psychology, the Law of Parsimony has been, for many purposes, quite satisfactorily stated in what is known as Lloyd Morgan's Canon, which is here quoted from his *Introduction to Comparative Psychology* (1894): "In no case may we interpret an action as the outcome of the exercise of a higher [mental process] if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale." To illustrate Lloyd Morgan's Canon, let us suppose that our dog, caught in the forbidden pantry, cowers and whines piteously. What are the possible explanations of such conduct? Since the dog has been carefully trained to keep away from the pantry, and is an intelligent and well meaning animal, we may conclude that he is suffering pangs of conscience. One can discern remorse and penitence in his tones; he obviously regrets the sinfulness of his ways. Another explanation might be this: When the master happens upon the dog, the animal consciously remembers—has in fact a vivid mental picture of—what happened when he was last surprised in the pantry. On the basis of this memory revival, it was easy for the dog to reason what would probably be shortly forthcoming, hence the cowering and whining. A third explanation would be: The dog has for good reasons cowered and whined when previously caught in the pantry. Now, being confronted by the man-pantry situation he reacts by cowering and whining. This would be a direct motor reaction unattended by "conscience," "reason," "conscious memory," or any other "higher" mental process. The dog does not know why he cowers and whines. He does not recall a previous punishment. The cowering and whining have merely become attached to or associated with the general situation—being caught by his master in the pantry.

The psychologist would probably accept the last explanation (or one somewhat like it) because it is simplest in the sense of being lowest in the scale of psychological explanations.

Psychology more than most sciences must be rigid in applying the Law of Parsimony, because fanciful and mystical explanations are supplied with such readiness.

The prevalence of beliefs in magic, clairvoyance, telepathy, mind reading, mystic inspirations, premonitions, intuitions and mind cures is illustrative of the readiness with which the supernatural rather than the simplest of psychological explanations are accepted. A New England girl, Beulah Miller, found herself possessed of a mysterious ability to divine many of her mother's thoughts; for example, she could tell whether her mother was thinking about the clock, the carpet or the window, about the number six or ten. The girl was entirely ignorant of the means by which she accomplished these feats. While thought transference, independent of the channels of the ordinary senses, is suggested by such a performance, the psychologist must search for simpler explanations. In this case it was found after careful investigation that the girl, without knowing it herself, was getting her cues from slight eye, lip or bodily movements of the mother who was not aware of having made them. The *real* explanation then, need not involve any form of mental telepathy or mind reading. The girl merely responded to visible signals.

The Use of Laws in Prediction.—Guided by rules, samples of which have been suggested, hypotheses are formulated, tried out to be discarded or to be advanced to the stage of a recognized theory, and if fully verified, to be finally accepted as a law, principle or general truth. Laws or principles are what sciences eagerly seek. The prime value of the general law is that it provides the means of making predictions, explaining all manner of particular facts and foretelling consequences. The astronomer utilizing the laws concerning the movement of planets can predict the exact moment at which the sun will rise each day for many years in the future. The physician observing certain symptoms, pulse, temperature and the locus of pain, by virtue of known principles predicts, with more or less accuracy, the course of a disease and arranges the treatment accordingly. The psychologist, utilizing the principles of mental growth, predicts, at least roughly, from the results of an examination made at age seven, the degree of mentality that a particular pupil will possess at fifteen, and as such predictions become more precise, the educational and vocational treatment of children may be more adequately selected and controlled to suit the ability and needs of the particular individual. In so far as we are able to predict the future from the present, we may be able to meet the future more adequately. Prediction is an ultimate aim of scientific endeavor.

Summary.—The scientific method is the result of extensive study of the difficulties and pitfalls in observation and the defects and deficiencies in generalizing from observed facts. It comprises improved methods both of observing and generalizing from data observed. Scientific knowledge differs from "popular" ideas mainly in these respects: it is

(1) More definite and precise.
(2) More accurate and valid.
(3) Better analyzed and organized.
(4) More universal in application.

The essence of science is its method. What distinguishes one science from another is the subject matter studied. Psychology is a science so long as it abides by the rules and regulations of the scientific game. Psychology, then, is the application of the methods of science to the study of certain data. What the data are and how they yield to or resist scientific attack should receive brief consideration.

THE SUBJECT MATTER OF PSYCHOLOGY

General psychology seeks to explain the behavior of living organisms, human or animal. The subject matter of psychology, as a method applied to the study of mankind, is human behavior or human conduct. We must now inquire a little more carefully into the varieties of human behavior and conduct which can be studied by the scientific method.

Types of Behavior That May Be "Objectively" Studied.—There are, in the first place, many types of behavior which may be observed "objectively." When the subject of investigation is another person or animal whose activities, such as movements of hand or limb, facial expressions or vocalizations, may be observed directly or by the aid of recording or measuring devices, psychology may utilize precisely the methods of other natural sciences—physics, chemistry or botany. The behavior of a man or animal may be studied quite as directly and scientifically as the bending of a steel rod under weight, the activities in a mixture of chemicals or the movements of the petals of a flower shifted from darkness to light. Just as in other sciences, all of the devices and precautions, which form the essence of the scientific method, may be utilized in the study of human and animal behavior. When the investigator restricts himself to observations of movements of limbs, eyes or facial muscles, to observations or records of vocal expressions, glandular activities or secretions which may be directly observed or recorded by an instrument; when in sum, the investigator observes features of the behavior of an animal or man which other investigators could also study—were they present—the method is termed *objective*.

Types of Behavior That Must Be Studied "Subjectively."—While psychology can go a long way by studying those events which may be observed by several persons, it encounters some interesting and important forms of behavior which can be observed by only one person. As I now write, other persons could observe and report the movements of my fingers and the words which result. I may, however, observe other facts. I may be aware of stiffness and soreness in my fingers, of the desire to finish this section of the chapter before lunch, of annoyance at the ringing of the telephone, and I may recall vague visual impressions of the location of the telephone. No one can share these observations; no one can verify them exactly. No one can at present record them by graphic or photographic devices, by chemical analysis or in any other way. At present they are facts that only I can observe. They are therefore called subjective experiences or events; the method of observing them is usually termed *Subjective* or *Introspective* and the activity of observing is often called *Introspection.*

It should be stated, however, that the terms *introspection* and *introspective method* are not in the best repute in many quarters because they tend to imply too large a difference between observations of subjective events which may be made only by one person and the observation of other events which may be made by several persons at once. So far as a single observer is concerned, there is little difference between attending to and reporting a toothache or a "tune running in the head" and attending to and reporting a flame of light or the sound of a violin. In both cases, one has an experience to which one attends and which one may report then or later. Really the main difference is that I alone can attend to and report the pain or sound image whereas other persons could also attend to and report the flame of light or the sound of the violin. The important question, therefore, is whether psychology as a science can rely upon observations which only one person can make.

Of the many experiences which only one person can become aware, some seem to be more difficult to observe than others—quite as some sights or sounds are more difficult to perceive than others. Although no one else can experience my toothache, I seem to be quite as clearly and surely aware of it as I am of anything else. At the other extreme among my private experiences is the flowing of various "mental images" which are very difficult for me to observe. Since the observation of my activity of imagining is among the most difficult forms of subjective study, suppose you try it as a means of getting acquainted with the limitations of observing "subjective" behavior. You may carry out a classic study by means of which an eminent scientist, Sir Francis Galton, first disclosed some interesting facts about mental imagery. Seat yourself comfortably and try to recall as vividly as you can the morning's breakfast table. Can you see, in your mind's eye, the table, dishes, faces, food and other details? Are these visual images dim or clear? Are they as bright as the actual scene? Can you really image the colors of the china, of the toast, eggs, coffee, etc., quite distinctly? Can you image the whole scene at once? For example, can you image all four walls of your room at once, or only the area that you could see from the particular position in the room? Where do the images seem to be situated? Within the head, within the eyeball, just in front of the eyes, or at a place corresponding to the real situation of the room? Can you retain the image steadily? With or without effort? Can you project it to the wall?

If you should now ask other persons who have tried the same experiment whether it is easy or difficult to observe these images, you would probably find differences of opinion. If you should ask those who felt confident of their ability to observe and report these experiences the answers to the various questions—whether they could "see" colors, where the colors were, etc.—you would probably secure different reports. If one person reports that he can "see" clearly the outlines or forms of the table and dishes, but cannot "see" the colors, whereas you can see both, what shall we conclude? There is no way now known by which either his imagery or yours can be photographed or otherwise recorded or detected nor can either be exposed to the observation of other persons. Such subjective observations therefore fall short of the ideal scientific program in two respects:

(1) The activities under observation cannot at present be readily objectified or measured, and
(2) They cannot be repeatedly observed by other investigators.

Because of these limitations, some psychologists distrust, and refuse more or less completely to utilize, such subjective or one-person reports. They declare that observations which cannot be repeated by different observers cannot be confirmed and are therefore useless for scientific purpose. Psychologists of this opinion are usually called *Behaviorists*. They confine their study to those events which can be observed by more than one person.

The majority of psychologists approve the use of subjective observation while recognizing its limitations. Those who favor the method contend that if similar experiences are reported by different persons independently, or if the same observer, known to be well trained, careful and trustworthy, has the same experience *repeatedly*, the observation should be considered valuable for science. In Galton's experiment, for example, many trustworthy individuals repeatedly found that their imagery of the breakfast table was "brilliant, distinct, never blotchy," others found it "fairly clear, brightness at least from one-half to two-thirds of the original," while others found their imagery to be "zero—no visual memories—recollect but do not see the scene." These reports are at once of useful reliability and in rough quantitative terms. The investigator may arrange a "scale" in which the highest degree of vividness is connected with the lowest by a number of steps or units which are roughly equal.

Such observations are admittedly difficult, however, and unusual care must be exercised in utilizing the results. It is the hope of most psychologists, however, that future discoveries will enable us to check up all subjective reports by objective devices as the subjective experience "hunger" may now be more or less reliably checked up by recording certain stomach contractions which usually accompany the hunger pangs, or, as the excitement produced by thinking about a stirring event may now be frequently detected in records of instruments which are influenced by changes in the activities or glands and other vital organs.

At the present time the only method of approach to some problems of interest to students of education—such as the rôle of imagery in learning to spell or in problem solving—is to use the testimony of the observer concerning his own experiences. Such results will be drawn upon but sparingly in this book.

Types of Individuals Studied

The Study of Normal Human Adults.—In developing the facts and principles of general psychology prior to 1900, the normal human adult was the most frequently used subject. By a "normal" adult is meant a person, eighteen or more years of age, without conspicuous defects or deficiencies. Before 1900, studies by the method of introspection received relatively more attention than they do now. Because considerable training was assumed to be necessary for subjective observation, introspective study was almost wholly confined to adults. As subjects of the more refined methods of objective study, embracing the features of the experimental method and as subjects for introspective observation, college students and instructors have mainly served. Since these persons represent a rather select group in some respects,—for example, in education—there is always some danger that the results will not be typical of all mankind. It has therefore been necessary to check up these results by experiments upon and observations of other people, dull, average and bright, in the varied activities of everyday life as well as by precise investigations in the laboratory. In addition, facts and principles concerning the behavior of normal adults have been sought, especially since 1900, by investigations of abnormal adults and of animals and children, both normal and abnormal.

The Study of Children.—Infants and children are studied not only to provide an understanding of their behavior, but also to make more intelligible the behavior of adults. Because they are less complex and less distorted by training than those of adults, the native or inherited tendencies of infants and children are especially worthy of study. The learning of children, because of its relative simplicity and because it may be observed from the beginning, has been a fruitful field of research. Young children are not highly reliable in reporting their experiences; hence introspective study is hazardous.

A profitable procedure in the study of children is the *genetic method* which consists in following from year to year the growth of vocalization and speech, emotional tendencies, the capacity to memorize and other traits. Among the early genetic studies are a number of detailed biographies based on observations of significant acts, remarks and interests of individuals from birth to various stages of childhood. More recently, a larger number of infants in maternity wards have been the subjects of daily observation by more carefully controlled methods. Where the behavior of such infants could not be objectively measured by timing devices, graphic recording apparatus, etc., it was frequently recorded by motion pictures, thus providing ample opportunity for observation by any number of interested investigators.

Of the whole period from birth to maturity, the span from 6 to 14 years—that is, roughly, the period corresponding to the elementary school—probably has been most thoroughly studied, partly because a larger proportion of the total population is available for investigation at these ages and partly because the schools, more than most other institutions, are alive to the value of scientific studies of their problems. It is in this field that measurement of human traits by means of standardized tests and scales, and studies of learning in school and other functions, have made the greatest advances. It is here that studies of individual differences, the character of variations in abilities and their correlations have been most extensively pursued.

The Study of Animals.—In attempting to arrive at the general laws which govern human conduct, the study of animals, like the study of children, has been fruitful—and for much the same reason: the relative simplicity of their behavior. In dealing with animals there is another great advantage; their activities can be much more thoroughly controlled. Whether cats will catch mice, or whether birds can fly without practice or without observation of the performances of others, may be determined by completely isolating the animal until the time when these activities usually appear, whereupon the animal is confronted, for the first time, with a mouse or an opportunity to fly.

Under conditions similarly controlled, the learning of animals, because of its relative slowness and simplicity, has been the subject of extensive investigations by which, probably more than by observations of humans, the principles of learning have been determined. In addition to studies of instinctive behavior and the learning process, the relation of the sense organs and the nervous system to behavior has been investigated by methods often more adequate than those applied to human subjects, for the reason that it is possible by means of operation to observe the loss or distortion in behavior which follows the removal of bodily organs in whole or part. Finally, the evolution of bodily organs from the simple to the complex may be followed in the animal species and correlated with the development of behavior. Since there is every reason to believe that human behavior, like human structure, is in many respects similar to that of animals even if much more complex, the study of the relation of structure and behavior in the latter has been of great utility in interpreting human conduct.

The subjective or conscious experiences of animals, of course, cannot be directly studied. At best, it may be indirectly inferred from their behavior; and such practice is too risky to yield information of much value in interpreting the human mind.

The Study of Abnormal Individuals.—Among animals, children and adults, individuals who deviate widely from the average either by inherited deficiency or aptitude or by acquired defects or ability have been found worthy of study, not only for their own sake, but also because they often disclose in sharp relief the presence or absence of a normal function. Just as a defective part of an automobile attracts our attention and leads to a closer understanding of its function, so among children who are normal except with respect to their incapacity to learn to read or spell we may often by the identification and study of a particular defect secure a better understanding of the child and the function.

Studies of the blind or deaf, of those suffering less severe sensory defects, of patients whose brains have been partly destroyed by accident or disease, have contributed greatly to knowledge of the functions of these organs in normal life. In delinquent children, criminal adults, the insane, in the emotionally or nervously unstable, common human functions are often found in such limited or exaggerated form that they may be the more readily observed. The equipment of the extraordinary musician, mathematician, mechanic, or executive may display other traits in extreme form which may be profitably investigated.

The Study of Groups.—To profit most fully from studies of the extremes, whether above or below the average, it is necessary to consider the intermediates as well. For this purpose various devices for group observation or measurement have been invented; many statistical methods have also been devised by which the whole array of abilities, from one extreme to the other in a group, may be considered at once. Of these, the technique of correlation is most familiar. It is a device by which the interrelations of two (or more) abilities in a group of individuals may be determined. Thus, by determining both the speed of memorizing and the length of retention of material by a group of subjects, we may ascertain whether, in general, rapid learning is associated with rapid forgetting, with slow forgetting, or with neither. By the same device it is possible to determine whether the rate of reading is, and to what degree it is, correlated with depth of comprehension, with general mental ability, or with any other ability that can be measured.

Doubtless the largest group study conducted by means of scientific instruments under standardized procedures in the field of psychology was the measurement of the mental abilities of nearly two million men in the American Army during the Great War by means of "group tests." From these data, correlation of mental ability with height, weight, nationality, schooling, vocation, army achievements and other abilities have been computed. In this way, much was learned concerning the organization of human abilities and the factors, native or acquired, that influence them.

Psychology for Students of Education.—In a Psychology for Students of Education most of the laws and principles which constitute General Psychology will be utilized. Of the innumerable particular facts gathered in the several branches of the science, many of them—of use to the physician, the lawyer, the advertiser, the salesman, the musician, or other people—are of relatively little importance for the student of education. The following chapters will include those principles and many of the particular facts from psychology (and many borrowed from other sciences, as well) which seem to have the most important bearing on education.

QUESTIONS AND EXERCISES

1. Judging from the account of the reliability of observation, would you expect a well trained physicist necessarily to be a good observer of children? Explain.

2. Do you believe that by vigorous daily practice in observing and reporting the contents of pictures or store windows you would become a better observer of these data? Would you also become a better observer and interpreter of the behavior of school children?

3. Do you believe that pupils in the second grade are better or poorer observers of facial expressions and their significance than pupils in grade 8? Explain.

4. How do you explain the "tall tales" which many young children tell about their affairs?

5. Name an instrument which the physician uses to improve his observation. Name some phase of medical diagnosis in which a quantitative record or measurement is secured? What is probably the ideal form of diagnosis in medicine, that based upon the doctor's observation of the patient's appearance or that based on objective tests? Why?

6. Does the physician ever require a patient to use the introspective method i.e., to report subjective symptoms? Why does he do so? Do you think he would prefer other methods of diagnosis? In what respects, then, does the physician's procedure differ, if any, from that of the psychologist?

7. Illustrate instances in which a teacher does each of the following in the classroom:

   (a) Depends upon ordinary observation.
   (b) Uses a mechanical aid to observation.
   (c) Applies an objective, group test.
   (d) Reduces an observation to quantitative terms.
   (e) Requires a pupil to report a personal, or subjective event.

8. Is introspection the same process as reasoning or philosophizing?

9. A survey test of a city school system showed that school 98 surpassed 26 in all subjects by nearly thirty per cent. Would the superintendent be justified in concluding that better teaching had been done in the first school? Explain.

10. Criticise the following conclusions in the light of scientific methods.

   (a) A man asserted that women are emotionally unstable because his sisters are more often "upset" than he is.
   (b) The fact that college graduates earn larger salaries at 40 years of age than persons of the same age who did not go to college proves that a college education increases one's earning power.

(c) The fact that the best reader in the class was taught by the phonetic method proves that this method is better than that applied to any other member of the class.

(d) The fact that the oldest living inhabitant of the state smoked since he was fifteen years old proves that smoking increases the length of life.

11. Out of brilliant red paper, cut a cross about 6 inches long with arms about 2 inches wide. Place the cross on a gray or white wall at a distance of about 10 feet. Gaze steadily at it for about ten seconds. Then shift the eyes to a blank wall and gaze fixedly until the "afterimage" appears. Carefully report the size, color, stability, etc., of the "afterimage." Try with different shapes and colors. In this experiment, what method is mainly used? How would you make such observations scientifically valuable?

12. Try the same experiment with children of various ages. Compare their ability to see afterimages with the ability of adults. Do you think children will make reliable observers of such facts? At what age do some of them succeed?

13. What, if any, are the distinctions between an hypothesis, a theory, a law, a principle? What is the difference between a scientific law and a civil law?

The following exercises are designed to assist the student to test his mastery of the text. After doing these exercises, compare your answers with those of other students. Discussion and re-reading of the text in cases of disagreement is usually valuable. It is even more valuable for each of several students to make up exercises of these types and try them on each other. For this reason, exercises of these types are provided only at the end of this chapter as samples.

A. *The Multiple Choice Tests:* Mark the one best answer with an (X).

1. Psychology is mainly concerned with
   ( ) Problems concerning the immortality of the soul.
   ( ) Telepathy and mind reading.
   ( ) Ordinary thinking, feeling and conduct.
   ( ) Ordinary digestion, breathing and heart action.
2. Psychology differs from popular thinking mainly in
   ( ) The kind of problems it attempts to solve.
   ( ) The lack of practical value in the results.
   ( ) The irreligious attitude it takes toward life.
   ( ) The precision and care in the methods of study used.

B. *The True-False Test:* Mark each statement true or false.

1. Experiments show that scientific men are poorer observers of human behavior than other men because of their preoccupation with their own ideas.

2. Psychology utilizes but one method, namely, the method of introspection.

3. The difference between an hypothesis and a principle is a difference in the degree to which an explanation has been verified.

4. The genetic method is one in which the behavior of an individual is observed during the period of growth.

C. *The Completion Test:* In the blank spaces in the following sentences, write words that make a complete and accurate statement.

1. Ordinary observation results in descriptions that are both ....and..........

2. The unreliability of ordinary observation is due partly to..........in the particular field, partly to the..........of the events and partly to the..........of the events.

3. We can estimate causes and..........only when all ....have been..........or taken into account.

4. Provision for the..........of an experiment or observation is an essential feature of the..........method.

5. Whenever possible, the investigator supplements or ....ordinary observation by the use of..........such as a..........or a..........

6. Whenever possible, the results of an observation should be stated in..........terms i.e., the facts should be..........

7. By means of statistical methods, the investigator should determine the..........of observations necessary as well as the ....of..........that should be observed.

D. *The Brief Response Tests:* Answer each in a word or phrase.

1. It was stated that in psychology, as in other sciences, the hypothesis is generally accepted which is simplest, which explains the most and is most in harmony with facts in related fields. What is the principle called?

2. When we have a trained observer, careful arrangement of conditions for observation, careful control of all influences and the recording of details during the study thus making provision for repetition, what term may be applied to the study?

3. What is the main function of the general law or principle in science?

REFERENCES

For a fuller treatment of the general methods of science, written especially for students of education, see W. C. Trow, *Scientific Method in Education*, Houghton Mifflin, 1925.

An able discussion of the relative merits of "introspective" and "objective" study will be found in H. L. Hollingworth's *Psychology*, Appleton, 1928, pp. 1–33. See also "Introspection" in the Index. For a criticism of introspection see J. B. Watson, *Psychology from the Standpoint of the Behaviorist*, Lippincott, 1919.

Useful exercises for discussion and study for this chapter and later ones will be found in J. P. Wynne, *Guide to Educational and General Psychology*, New York, Fordham Publishing Co., 1924.

Educational Problems for Psychological Study, by G. B. Watson and R. B. Spence, Macmillan, 1930, is an excellent volume of problems, exercises and case studies. It would form a very useful problem book to use with the present volume.

G. M. Ruch, of the University of California, and F. Knight, of the University of Iowa, have collaborated in the preparation of a syllabus for use with this book. The author heartily recommends this syllabus. It provides for abundant extension and application of the principles offered in this volume to genuine problems in education. The syllabus will be published by the Williams' Iowa Supply Co., Iowa City, Iowa.

CHAPTER II

THE ORGANISM AS A REACTING MECHANISM

As we observed in the preceding chapter, each science attempts to develop broad principles by means of which its particular facts may be explained. Until undisputably established, such general explanations are properly termed hypotheses or "working hypotheses." The good hypothesis must fulfill certain requirements. It must faithfully explain the particular facts on which it is based; it must be wide in its application, explaining all the facts within its field and it must afford the most simple and workable explanation. It must consequently be definite enough to be of value as a guide in practical affairs, such as teaching. It is furthermore desirable that a hypothesis should square up with facts and principles established in other fields, such as physiology or physics. Before describing the detailed principles of psychology in relation to education it is desirable, therefore, to present in brief a working hypothesis which is fundamental in all later explanations.

The Reaction Hypothesis

Briefly the hypothesis of this book is as follows: all forms of human behavior, whether muscular activities, such as grasping, walking and speaking; glandular activities, such as the secretion of tears, saliva and bile; or mental activities, such as seeing, hearing, becoming afraid or angry, recollecting or imagining, are reactions to definite stimuli. This may be called the *Reaction Hypothesis*.

Muscular Activities Are Reactions.—If a sharp pin-point is applied to an earthworm, a dog, an infant or an unsuspecting adult, the usual result is a sudden and pronounced movement. The essential features of this bit of behavior are, the stimulus, the reaction or response and some sort of connection between the two. The *stimulus* here is an activity or force which manifestly has some effect upon the organism; which arouses the organism to activity.

To produce a reaction effectively the stimulus must impinge on some sensitive portion of the body. The pin, in this case, was brought to bear upon one or more tiny sense organs which were located in or under the skin. Since the movements made in response to the stimulus were not all located immediately at the point of stimulation it is apparent that the effects of the stimulus on the sense organ were conducted over various distances to the various muscles. Examination, indeed, would disclose between sense organs and muscles an elaborate system of connections, the cells and fibers of the nervous system. It is a nerve impulse initiated at the sense organ by the stimulus and conducted through a system of nerve fibers (first to centers in the spinal cord or brain and thence back) which touches off the reaction in the muscles. The reaction, in this case a movement, is an activity produced by the release or transformation of energy. A muscular movement or "motor response" is due to the sudden release of forms of energy stored in the muscle.

A *reaction*, as the term is here used, means more than the mere transmission of energy from one object to another as when a moving billiard ball, striking another, throws the latter into action. The amount of energy released or transformed may be very much greater than the amount transmitted to the organism by the stimulus. A tiny prick occasioned by a very small amount of force may cause a reaction in which a relatively huge amount of energy is consumed, or more accurately, transformed. The organism contains at all times stored in various reacting mechanisms large amounts of energy which when released by appropriate stimulation occasion the body's activity.

That all motor activities are to be explained in terms of the stimulus-reaction formula is generally agreed since the mechanisms involved, the sensory or receiving mechanisms, the connection mechanisms and the reacting mechanisms, in this case the muscles, are fairly well understood and their combined activity may be observed with relative ease. In everyday experience we observe that a tickle causes a quiver or a sneeze; a pinch causes a jerk, a strong light causes a wink or the narrowing of the pupil of the eye. In the laboratory such simple reactions may be more precisely demonstrated, and in many cases the sense organs, nerves and muscles involved may be identified. The more complex motor activities such as talking, dancing, balancing on one foot, stopping a "grounder," playing a violin, although immensely more complicated both on the side of the stimulus and the response, nevertheless are of the same character as the more simple acts.

Glandular Activities Are Reactions.—If a strong light or a cinder strikes the eye the muscles of the lid react causing a wink; the eye may also be promptly moistened by a flow of tears. The tears, like movements, are the results of a reaction; the reacting mechanism in this case being a gland—the lachrymal gland. In a similar way heat will cause the sweat glands to react, a taste of sweet, the salivary, and certain substances in the stomach, the digestive glands. In the simplest instances, then, glandular activities are brought forth by stimuli which affect sense organs within the body or on its surface. While muscles and glands may differ greatly in structure and while movements and chemical secretions are very different sorts of products, both are similarly produced in the sense that they are the results of reactions of bodily mechanisms activated in an orderly way by stimuli.

Conscious Experiences Are Reactions.—When the human subject is stimulated by a pin prick, a ray of light or a sweet substance, characteristic muscular and glandular reactions occur and the subject becomes conscious of the pain, the light or the sweet taste. Since these sensations are purely personal experiences not apparent to other observers they are often conceived as rather mysterious activities differing in kind and control from movements and glandular secretions. It appears, however, that they followed upon and were activated by the stimulation of sense organs. They seem to appear as surely and uniformly and to be as law-abiding as the others. In these instances, at least, they may intelligibly be conceived as reactions. More complex conscious experiences similarly are reactions; that is, they are not spontaneously brought into existence but aroused by definite causes. When pricked by a pin the subject is first aware of the pain; and at once he may realize that the pain was caused by a pin—he perceives the pin. The event, furthermore, may arouse some resentment or anger, an emotional response; it may lead to the recollection of the circumstances that led to the unfortunate location of the pin, to imagination of serious consequences which may result from even so slight an accident, to reflection or reasoning as to the means of forestalling such a possible result. Thus to a simple stimulus a variety of conscious reactions may be made. They do not appear without some adequate cause; they are, like movements and secretions the result of the activities of mechanisms within the body.

Stimulus and Response Are Always Complex.—In the illustrations of behavior just given, both stimulus and response have been pictured in extremely simple form.

In everyday life, both the stimulus and the reaction are typically complex. The reaction is never merely an isolated muscular or glandular or conscious activity. It is typically a complex yet highly organized combination or pattern of muscular, glandular and conscious activities. The stimuli which produce the reaction of the organism at any one moment are never so simple and few as they were pictured above. The reaction is always produced by a large number of stimuli acting at the same time. Such a combination is often called a *situation*. The boy reading his book or the man walking along the street is not responding to one stimulus only although some one element of the situation may be predominant. Many other stimuli such as objects and events seen "out of the corner of the eye," cries, honks and rumbles, odors, good or bad, heat and cold, are effective at the same time. Compare the effects of the ghost story on a boy surrounded by people at midday and a boy by himself at night! Often equally influential are stimuli which result from activities in his own body, his muscular and glandular activities, his mental activities,—ideas, emotions and purposes—and such general conditions as those of fatigue, irritability, hunger or hurry. To explain fully what the person does or to foretell what reactions will be made next it is necessary to take into account all of the stimuli, inner and outer.

The Relations of the Bodily Mechanisms.—To understand the variety of stimuli to which the human organism may react we must first observe the relations among the various organs involved in typical activities. The mechanisms that we shall need to know may be divided into three groups: (1) *the receiving organs*, such as the eye and ear; (2) *the reacting organs*, such as the muscles and (3) *the connecting organs*, the elements of the nervous system.

First among the organs is the *receiving apparatus*, sometimes called the *sensory apparatus;* most commonly the *sense organ.* The sense organ always contains one or more *receptors* which are highly sensitive to certain kinds of stimuli. The function of the receptor is to initiate a nerve impulse. Each receptor is in contact with the endings of a nerve. The impulse, resulting from the stimulation of the receptor, is conducted by the nerve to switching stations in the spinal cord or brain. After more or less switching about, the nerve impulse finally is conducted by other nerves to muscles or other mechanisms where the reactions occur. The order of events then is: (1) the stimulus affects in the sense organ the receptors which (2) initiate a nerve impulse which (3) is conducted through the nervous system and (4) finally issues into the reacting mechanisms. The whole system is usually thought of as a unit, a *reaction unit* or a *stimulus-response unit.* (See Figure 1.)

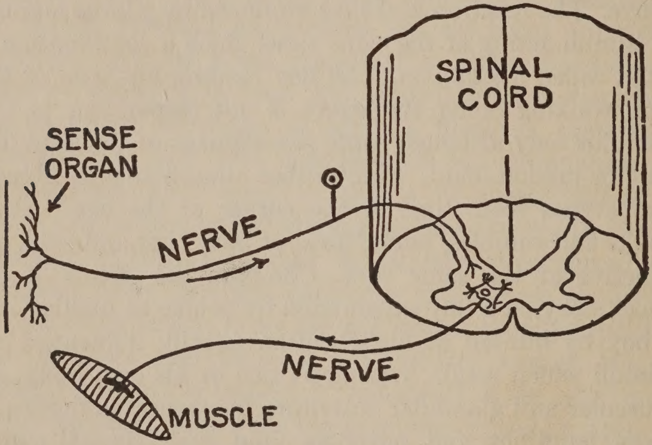


FIG. 1.—A SIMPLE REACTION UNIT, OR SITUATION-RESPONSE UNIT. This consists of the receiving mechanism (the sense organ) the connecting mechanism (the nerves) and the reaction mechanism (the muscle). The arrows show the direction of the nerve impulse.

THE RECEIVING MECHANISMS

Sense Organs in General.—Sense organs vary greatly in complexity. The eye and ear are most elaborate; the organs for pressure and pain are the simplest. The differences in complexity are due mainly to *accessory structures* which are not sensitive to the stimulus. Differences in the *receptors*, that is, the sensitive cells, are too minute to appear to the unaided eye. The receptors are absolutely essential to the initiation of the nerve impulses; the accessory apparatus such as the external shell of the ear is usually of service but not always indispensable. The receptors are usually well protected; one of the functions of the accessory apparatus is the protection of the sensitive cells.

Although usually far too small to be visible to the naked eye the receptors are highly specialized. Each type is sensitive under ordinary conditions to only one kind of stimulus. The receptors in the eye are highly sensitive to light waves but are entirely insensitive to sound waves to which the sensory cells in the ear are attuned. Neither light nor sound waves arouse any other receptors under normal conditions. Certain intense stimuli such as an electric shock, a strong chemical or a sharp blow may initiate a nerve impulse in any sense organ, but this is an unusual event and such stimuli should be considered as *abnormal stimuli*. The normal stimulus is the one to which the sense organ is especially adapted, the one which usually affects it.

Types of Receptors.—In the following list are given most of the best known types of sense organs.

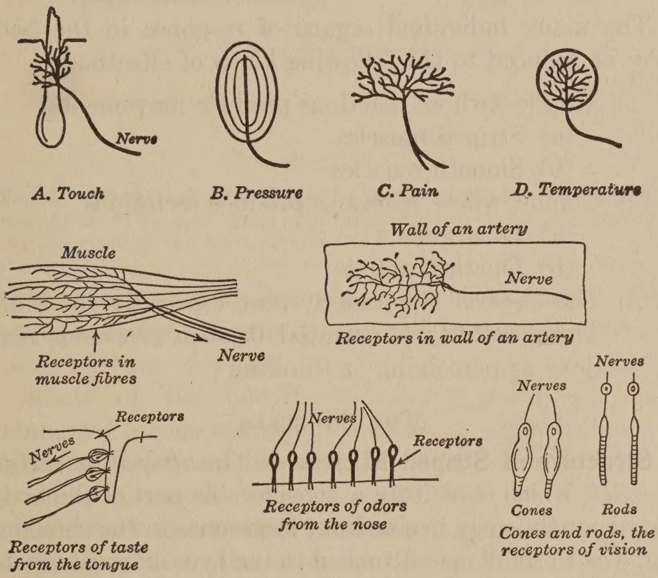
SENSE ORGANS	STIMULUS
1. The eye	Light waves of various lengths
2. The ear	Sound waves " " "
3. The organs of equilibrium in the inner ear	Movements of the head

SENSE ORGANS	STIMULUS
4. Organs of smell in the nose	Various chemical substances in gaseous form
5. Organs of taste in the mouth	Various chemical substances in liquid form
6. Organs in the skin: (a) Sense organs of pain (b) Sense organs of touch and pressure	Various mechanical, thermal, chemical, electrical and other forces
(c) "Cold spots"	Temperature lower than that of the body
(d) "Warm spots" and possibly others	Temperature higher than that of the body
7. Various sense organs in skeletal muscles, stomach, heart, arteries, and other organs within the body	Various chemical, mechanical, thermal and other forces

Figure 2 pictures a number of the better known receptors. There are probably many types not as yet discovered or fully described. The total number of receptors in the body defies count. There are, for example, probably more than two million sense organs of *pain* in the skin alone.

Sense Organs and Sensations.—Our everyday experiences lead us to think of the sense organs in connection with what are usually called *sensations.* When we think of the ear, we think of sounds; the eye goes with colors; the nose with odors; the skin is thought of as the seat of cold, pain, pressure and warmth and the interior of the body with many sensations and feelings. While it is true that the ear is involved in hearing sounds, and that other sense organs are needed to enable us to experience other sensory qualities, it is incorrect to assume that the sense organ is *alone* sufficient to produce a conscious experience. The hearing of sounds requires bodily apparatus other than an ear. It requires an ear properly connected by nerves with other parts of the body, especially with the brain. Hearing a sound is the result of a very complex reaction of the organism in which the activity of certain parts of the brain is essential. This fact that *sensing* is a response of the whole organism, especially of the brain, and not the result of *mere* stimulation of the sense organ alone will be taken up again later.

The main fact which we now need to know about the human equipment of sense organs is that it includes not



A. Touch B. Pressure C. Pain D. Temperature

Receptors in muscle fibres

Receptors in wall of an artery

Receptors of taste from the tongue

Receptors of odors from the nose

Cones Rods

Cones and rods, the receptors of vision

FIG. 2.—ROUGH DIAGRAMS OF TYPICAL RECEPTORS. All of the drawings are greatly enlarged and many details are omitted. The figure is intended merely to show the variety of types of which these are but a few.

only the familiar organs for seeing, hearing, tasting and smelling and a large number of pressure, pain, cold and warm receptors in the skin, but also literally millions of other receptors in the inner organs of the body. The whole interior of the organism is richly equipped with receptors which are sensitive to many sorts of activities and conditions in the organism itself. Since activities and conditions within the organism affect these sense organs, the reactions of the body really produce stimuli which lead to further responses. It is a case of activity leading to further activity. Before pursuing this point further let us consider briefly the characteristics of the various organs of response.

THE REACTING MECHANISMS

The many individual organs of response in the body may be reduced to the following kinds of effectors:

(1) Muscles, whose reactions produce movements
    (a) Striped muscles
    (b) Smooth muscles
(2) Glands, whose reactions produce secretions
    (a) Duct glands
    (b) Ductless glands
(3) The Central Nervous System, especially the brain, whose activity is essential to such conscious reactions as perceiving or thinking

THE MUSCLES

Structure of Striped Muscles.—The *striped* or *skeletal* muscles, which constitute a considerable part of the body, vary tremendously in size from large ones in the shoulders and legs to small ones attached to the eyes or vocal organs. Each muscle consists of a number of threadlike cells, the *muscle fibers*, which lie parallel to one another—hence the striped appearance. Each fiber is supplied with fibrils from the discharging end of nerve fiber. It is by this means that the nerve impulse, coming from the spinal cord, produces a reaction of the muscle.

The Neural Circuit.—Each muscle contains receptors, as well as the endings of *motor* nerves which cause the organ to react. The reaction of a muscle stimulates the receptors thus sending to the cord, by *sensory* nerves, impulses which may result in other reactions, in the same or in other muscles. The nerve connections involved, shown in Figure 3, constitute what is usually called a *neural circuit*. It gives in simplest form the basis of continuous activity, of activity leading to further activity.

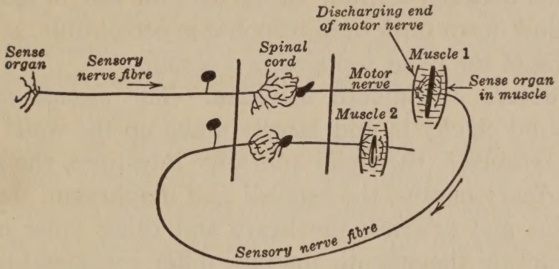

Discharging end of motor nerve
Sense organ
Sensory nerve fibre
Spinal cord
Muscle 1
Motor nerve
Sense organ in muscle
Muscle 2
Sensory nerve fibre

Fig. 3.—Diagram of the Neural Circuit. Assuming that the stimulus is applied to the sense organ in the upper left corner, the diagram shows the circuit made by the nerve impulse.

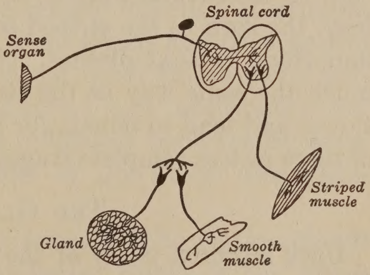

Spinal cord
Sense organ
Striped muscle
Gland
Smooth muscle

Fig. 4.—Nerve Connections with Striped Muscles, Smooth Muscles and Glands. Note the extra link in the latter two cases.

Any posture of a part or whole of the body maintained for an appreciable time illustrates also the operation of the neural circuit, one activity leading to others. When one holds a pen, stands or sits in one position, keeps the eyes fixed on one point in space, many muscles are continuously in contraction while others are actively inhibited. That these postures are really states of high activity, that they are genuine reactions and not merely passive conditions, is indicated by the fact that many are very fatiguing. The continuous reaction is produced by series of intermittent nerve impulses, twenty or more per second, whose rapidity is too great to permit a return to the state of relaxation between stimuli. In old age, the rate of discharge may slow down until each response is perceptible, as in the shaking of the hand supporting a teacup.

Structure of Smooth Muscles.—The *smooth muscles* are found chiefly in and largely make up the walls of the gullet, stomach, the small and large intestines, the genital and urinary organs, the bronchi and diaphragm, the walls of veins and arteries, the heart and other inner organs. In structure the smooth muscles differ considerably from the striped; instead of threads the elements are tapering spindles which unite to form a tissue such as the wall of the stomach. Figure 4 shows how the nerves are connected with the smooth muscle. Although there is an extra link in the sense of nerve fibres leading from the cord to the smooth muscle, as compared to the one fibre from the cord to the striped muscle, the difference is unimportant to us at present. The smooth muscles react in much the same way as the striped, except that they are slower and tend to remain for longer periods in conditions of more or less complete stages of contraction.

THE GLANDS

Until recently, study of the glandular mechanisms has been pursued rather exclusively by those interested in digestion and assimilation of food, in storage of reserves such as fat, in growth and in the elimination of wastes. Recent research, although not as yet extensive, has shown that the glandular mechanisms play an important rôle in general behavior.

Duct Glands.—There are two general types of glands, the *duct* glands and the *ductless* glands. The most familiar *duct* glands are the tear glands, the sweat glands of the skin, the salivary glands in the mouth, the digestive glands in the stomach, intestinal canals, liver and kidney. Each of these, by means of a duct or tube, pours its secretion on the surface of the body or into some body cavity. The duct glands, like the smooth muscles, are connected with the spinal cord by means of an extra nerve fiber link as shown in Figure 4.

Although we rarely become conscious of the activities of the duct glands themselves, the functioning of these organs does have marked effects upon our behavior. The effects are manifest, at least, when the function of the gland is disturbed. Thus if a liver secretion, bile, is miscarried as in jaundice, the patient not only becomes yellow cutaneously but, what is more important to psychology, he tends to become blue mentally. If the digestive glands secrete unusual amounts of exceptionally strong hydrochloric acid, the victim's temperament may be markedly changed in the general direction of irritability. On the other hand, as these glands approach perfect functioning, the person is likely, other things being normal, to be most stable, cheerful and healthy-minded. The activity of the glands influences behavior by stimulating various sense organs in the body. (See pages 37–40.)

The Ductless Glands in General.—The *ductless* glands are sometimes called the *endocrine glands* or the *glands of internal secretion.* They differ from the duct glands in that they have no external outlet. They produce complex chemical compounds which are absorbed by the blood filtering through them and thus are carried throughout the body. The endocrine glands, like smooth muscles and duct glands are connected with the cord by a linkage of nerve fibers. We can give but a brief and fragmentary description of two of the internal glands, the thyroid and the parathyroid and merely suggest their influences on behavior.

The Thyroid Gland.—The thyroid gland consists of two maroon-colored masses connected by a strip of tissue on each side of the windpipe, close to the larynx. Everyone knows the position of this gland because of its great enlargement in the disease, goiter. The most important secretion of the thyroid is *thyroxin*, of which the most potent element is iodine.

When the thyroid becomes overactive, or when thyroxin is injected into the circulation or taken into the stomach, the effects, while slow in appearing, are very pronounced. The organism speeds up, is excitable and over-reacts. The pulse becomes rapid, the temperature goes above normal, and the skin is flushed and moist from perspiration. The individual is alert, irritable, unable to relax or sleep perfectly. Emotions, as fear, anger or excitable joy, are easily aroused. If the oversupply of thyroxin is continued, the individual loses weight no matter how much he eats; certain vital chemical activities (metabolism) go on at such a pace that they exhaust the reserve stores of the body.

When the thyroid is underactive, as in some diseases, the symptoms are quite the reverse. All of the vital activities slow up; bodily movements are slow and clumsy; the temperament becomes sluggish, indifferent, insensitive, dull.

The Parathyroid Glands.—The parathyroids are four in number, about the size and shape of grains of wheat, located two on each side of the windpipe and embedded in the thyroids. The secretion of these glands has not been isolated and its specific effect is not very well known. When they are removed in experiments upon animals, the subject becomes extraordinarily excitable. At the slightest sound or touch it will jump or even be thrown into convulsions. Certain human beings suffering from extreme depression, nervousness, restlessness, insomnia and tremors, have been found to have defective or diseased parathyroids. At the present time it is believed that these glands have an important rôle in the regulation of the assimilation of lime, which in addition to being an essential element of the bones, teeth and blood, is required for the health of nerves. Removal, disease, or insufficiency of the parathyroids, by eliminating or decreasing the intake of lime, and perhaps in other ways, produces marked disturbances of behavior.

The Glands in General.—Glandular activities, especially those of the endocrines,—of which there are several that we have not described and some of which we shall consider in later chapters—are markedly influential in determining bodily responses and conscious life. Especially important is their relation to the emotions, such as fear, anger and joy; to temperamental and volitional traits such as excitability, vivacity, energy and ambitiousness; and even on the mental processes of thinking and reasoning, they may exert a considerable influence.

Glandular reaction, then, presents a vivid illustration of activity leading to further activity. The secretions are particularly potent in prolonging altered activities inasmuch as they remain effective for considerable periods of time. The persistence of internal disturbances such as a rapid pulse and breathing following a shock or exciting experience is usually due to glandular secretions produced by these events. Intimately related to excitability and calm, fatigue and vigor, elation and depression, anger and fear, impulsiveness and poise, the internal secretions play an important rôle in general behavior that psychology must not neglect.

THE CENTRAL NERVOUS SYSTEM

The Physical Basis of Conscious Reactions.—Our next task is that of describing the physical organs which are responsible for *conscious* activities—for seeing a color, recognizing a friend, remembering an event, thinking out the solution of a problem, imagining a new scene and so on. One theory is that such mental activities are due to activities of the brain. The theory is that seeing, understanding, thinking and feeling are the results of reactions of the brain in somewhat the same sense that a movement is the outcome of the response of a muscle and that a chemical secretion is due to the reaction of a gland. Although science has not discovered in any detailed or ultimate way, *how* the reactions of the brain do come to result in various conscious activities, it is certain that the brain is a mechanism essential to conscious reactions. For that matter we do not know *exactly* how most other organs act. As an eminent physiologist, C. J. Herrick writes, "We do not know how a sense organ is excited, how a nerve fibre conducts, how a muscle contracts, how a gland secretes, or how the brain thinks, though we do have evidence that all of these organs do perform the functions mentioned."

One of the most important facts about human reactions is that they are typically not responses of an isolated organ or part of the organism, but of the organism as a whole. Neither muscular, nor glandular, nor conscious reactions result from activity of a single organ. They are all, in a real sense, reactions of the whole organisms. In normal life, moreover, muscular, glandular and conscious reactions do not appear in isolation from one another. They are typically combined and coördinated in complex ways. In order to understand typical conscious activity,

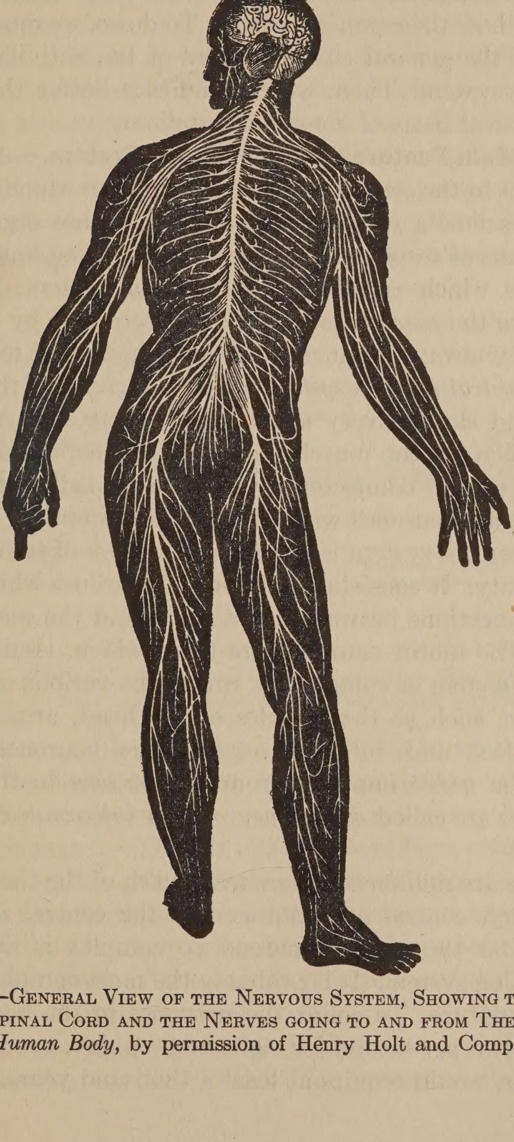


FIG. 5.—GENERAL VIEW OF THE NERVOUS SYSTEM, SHOWING THE BRAIN AND THE SPINAL CORD AND THE NERVES GOING TO AND FROM THEM. (From Martin's *Human Body*, by permission of Henry Holt and Company, publishers.)

then, we must show not only how a muscle or gland reacts, but also how the *organism* reacts. To do so, we must study some of the general characteristics of the activity of the nervous system. Then, we can indicate better than now the physical basis of conscious reactions.

The Main Features of the Nervous System.—A stimulus starts in the sense organ a nerve impulse which eventually occasions a response. Between the sense organs and the organs of response is a series of connecting links called *neurones* which constitute the nervous system. First in order are the *sensory neurones*, distinguishable by the fact that they always originate in a sense organ and terminate in the *central nervous system* which is incased in the backbone and skull. Every sense organ, every tiny receptor in the skin, in the muscles, internal organs, the eye, ear, tongue, etc., is connected by delicate threadlike fibers of the sensory neurones with the central system.

The central system is a switching station of tremendous complexity. It consists of millions of neurones which form interconnections between the sensory and the *motor neurones*. The motor neurones are those which, issuing from the brain stem or spinal cord, run to the various organs of response, such as the muscles of the head, arms, trunk, limbs, feet and internal organs. The neurones which carry the nerve impulses from the *sensory* to the *motor* neurones are called *central neurones* or *interconnecting neurones*.

There are millions of neurones of each of the three types —sensory, central and motor—but the central neurones are by far the most numerous, so complex is the interconnecting system. It is probably the most complex structure in nature. To count the neurones in the body, at a rate of two per second for eight hours a day, every day in the year, would require at least a thousand years.

Structure and Function of the Neurones.—Although differing greatly in size, shape and complexity, the neurones are alike in certain respects. Each includes a *cell body* and a number of fibers. The cell body is a small but complex structure essential to the life and function of the neurone as a whole. The fibers, which correspond roughly to telephone wires, conduct the nerve impulses from one to the other end of the neurone. These fibers are often grouped together like a cable of telephone wires to form a *nerve*. Some of these nerves, such as those leading from the cell bodies in the cord near the waistline to muscles in the feet, are very long.

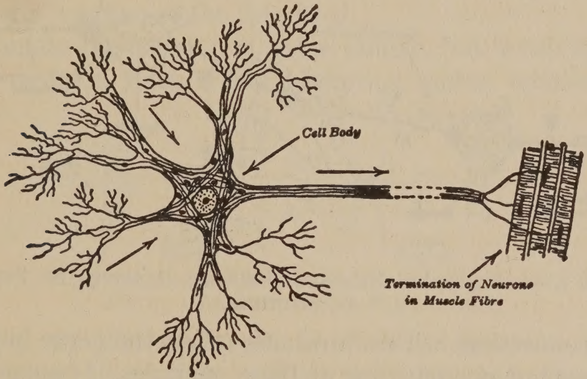


Fig. 6.—A Motor Neurone Highly Magnified. The fiber between the cell body and the muscle is sometimes several feet long.

The Synapse.—The central neurones form connections with the sensory and motor neurones and with each other —hence the alternate term, *interconnecting* neurones. We must give special attention to these junctions between neurones. The fibrils of two neurones do not actually unite or fuse; they merely come into contact or close proximity. Neurones are independent units, like trees with branches close together or intertwined. The points of close proximity or contact of the nerve fibers, which correspond to the branches of trees, are called *synapses* or *synaptic connections*. The synapse, then, is not an organ or thing but merely a place where the fibrils from two neurones come into contact or close together as electric wires are brought together in a switching board. Figure 7 gives a rough indication of such synaptic connections.

The nerve impulse gets from one neurone to another by crossing the synaptic connections. Usually each neurone has connections with several others but the nerve impulse crosses but one or a few of these synapses. At some synapses great resistance may be offered to the passage of the impulses; at others, relatively little. The impulse crosses only those synapses where the resistance is low. Thus the degree of resistance offered at the synapses determines the course a particular nerve impulse will take and, in effect, what reactions will be made.

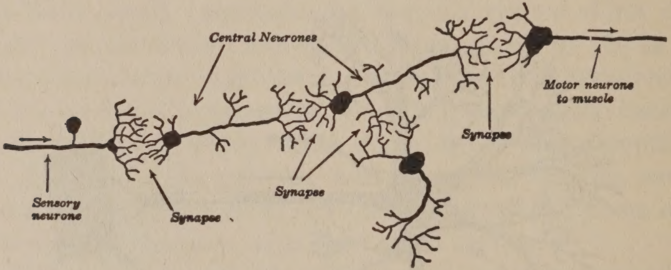


FIG. 7.—A SERIES OF NEURONES SHOWING SYNAPSES OR SYNAPTIC CONNECTIONS.

LEVELS OF ORGANIZATION OF CONNECTIONS

Routes and Reactions of the First Level.—The simplest stimulus-connection-response unit (which may be designated by the symbols S→R or S—R) consists of a sensory neurone, a central synapse or connection, a motor neurone and a muscle. Stimulation of the sensory neurone results in a response by the muscle. Thus a slight prick of the skin on the finger or eyelid would cause a contraction of a local muscle. There is always a slight interval between stimulus and response, since some time—1/30 of a second at least and sometimes as much as 1/5—is required for the nerve impulse to get under way, to complete the route to and from the central system and finally to arouse the muscle. Such a simple and relatively prompt S→R unit is often called a *reflex arc*, the reaction a reflex act or a reaction of the first level.

Usually the reaction is not so simple, but involves several muscles. Each sensory neurone makes connections with many effectors by means of central neurones in the cord. Not all of these will be activated, but usually a limited number, depending on the resistance encountered at the synapses.

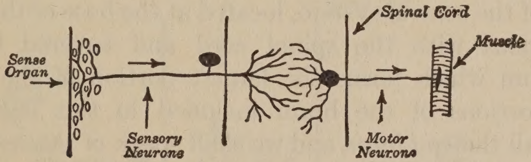


Fig. 8.—The Mechanisms and Connections Involved in a Reflex Act or a Reaction of the First Level.

Many reflexes or reactions of the first level may be observed in an infant shortly after birth. A prick on the infant's foot elicits a movement of the leg. Uncomfortable stimuli such as tickles, pricks, heat or cold applied to other parts of the body provoke prompt avoiding reactions. An object striking the cornea causes the wink reflex. Milk in the mouth causes a gush of saliva, a glandular reaction. Food on the back of the tongue causes a swallow; food in the stomach, gastric secretions and movements. A slight tickling of the nasal membrane causes a sneeze; an object on the palm of the hand, the grasping reflex.

Reactions on the reflex level are relatively prompt and certain, and may be fairly safely predicted. They are uniformly found in normal infants, and since they can be modified or inhibited only with greatest difficulty, they persist usually throughout life. For these reasons, tests of the first-level reactions have become an important feature of the diagnosis of disorders of the nervous system.

Routes and Reactions of the Second Level.—In addition to traversing one or more of the innumerable pathways of the first level, a nerve impulse started, for example, by a pin prick on the foot, may make its way to routes of a higher level which are contained in various parts of the central system, located at the base of the skull, continuous with the spinal cord and covered by the cerebrum which forms the largest portion of the brain. The portions of the brain included in this region we shall call the *mid-brain* and we shall speak of the responses as reactions of the second level or of the mid-brain level.

We observed that a sharp stimulation of the toe causes a jerk of the foot, the simplest reaction. Perhaps also movements of the hips, trunk, or arms occur—reactions which probably involve only connections or routes of the first level. In some cases, especially if the stimulus is a strong one, the subject may turn the head, readjust his equilibrium, gasp or shout and show internal changes such as an increased respiration and heartbeat. These reactions involve more complicated connections—connections of the second level. Such reactions as turning the head to sounds or moving arms up to things seen, or such complex inner reactions as appear during anger and fear, are usually second-level reactions. These routes are shown diagrammatically in Figure 9.

Reactions of the second level, as contrasted with those of the first level, as a rule take place in a part of the body somewhat more distant from the point of stimulation, and they are somewhat more complex, somewhat less rigid, less invariable and more readily modified. These distinctions are not sharp, however, and only the expert in neuro-anatomy is able to distinguish the levels involved in many reactions.

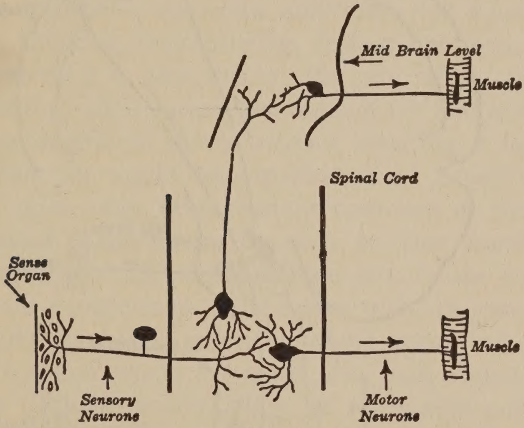


Fig. 9.—The Connections Involved in Reactions of the Second or Mid-brain Level. The neurone which runs up to the mid-brain and another which runs from the mid-brain to the muscle are added to those of the first level as shown in Figure 8. The broken line indicates that a large section of the cord has been cut out.

Routes and Reactions of the Third Level.—The largest portion of the brain consists of the two *cerebral hemispheres*, or *the cerebrum* which lies above and largely surrounds the mid-brain section which includes various parts to which technical names have been given. By means of a chain of neurones, a nerve impulse originating at any sense organ may finally reach the surface or *cortex* (literally the bark) of the cerebrum, which consists of a tremendously complicated network of neurones. From this point are possible almost numberless connections with other central neurones, by means of which effectors in any part of the body may be reached.

Reactions of the third level may be of any degree of complexity, involving few or a great many effectors near to, or remote from, the point stimulated. We found the immediate withdrawal of the toe or foot, when it was pricked, to be a reaction of the first level; the more general bodily readjustment, in turning of the head, the cry of pain, changes in respiration, etc., to be second-level reactions.

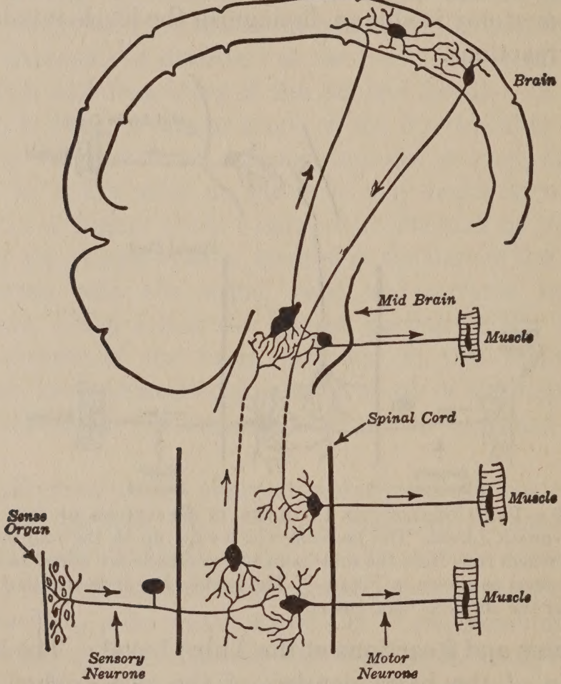

Brain
Mid Brain
Muscle
Spinal Cord
Muscle
Sense Organ
Muscle
Sensory Neurone
Motor Neurone

FIG. 10.—CONNECTIONS OF THE FIRST, SECOND AND THIRD LEVELS. The arrows indicate the direction of the nerve impulses. The area between the two lines at the top of the brain represents the cortex. See text for fuller explanation.

To apply camphor to the injured spot or to examine it deliberately would involve neural connections of the third level. All learned reactions, probably depend upon connections established in the highest brain level which includes the cortex.

The Cortex and Conscious Reactions.—According to a much respected theory, reactions of the cortex primarily are responsible for conscious activities—for sensing, perceiving, thinking, remembering, feeling emotions, imagining. According to this theory, the pin, when applied to the skin, may elicit various reactions of the first and second level, as described above without arousing a feeling of pain. The pin would be experienced or perceived as a painful prick only when certain neurones in the cortex are aroused. Experiencing the pain, in other words, is due to a response of the cortex. If you remove the cortex, or cut off the connections of the cortex with the lower levels, first- and second-level reactions would occur but no conscious reaction would be made. No pain would be felt and no thinking would follow as a consequence of the pain. According to this theory, all conscious activities are third-level reactions. They are, moreover, usually attributed to activity of the cortex; that is, to neurones in the outer layer of the brain.

An immense amount of research has been done in an effort to determine what parts of the brain, especially what parts of the cortex, are involved in different sensory experiences, in perceiving different kinds of facts, in feeling different emotions, in remembering, thinking and imagining. On the whole the results are as yet rather meager and difficult to interpret. Certain general facts seem however to be suggested, as follows:

First, the evidence indicates that the cortex is intimately concerned in conscious activities. Although the cortex normally operates as an integral part of the whole organism, it is the mechanism primarily and necessarily involved in conscious responses. Second, the evidence suggests that a normal conscious reaction, such as perceiving a pin which pricks the skin, or recalling such a prick, is due not to the action of any definite, circumscribed part of the cortex, but involves many—probably all—major parts of the brain. Sensations, ideas, images and the like are not each produced by the reaction of some little piece of the brain. Each conscious experience is the result of a reaction of the brain much as a whole. Sensing, perceiving and thinking, moreover, are intimately related and integrated. They are separated and named merely for convenience in speech. They are artificial aspects of, and not wholly distinct steps in, the process of consummating a reaction to a situation.

Third, if sensing, perceiving and thinking are properly to be conceived merely as phases of a complex, organized reaction and if there is neither psychological nor anatomical justification for the assumption that percepts, images, ideas, emotions and the like are localized in definitely circumscribed regions in the brain there is still less defense for the belief that obstinacy, will power, executive ability, amorousness, secretiveness and the like constitute distinct "faculties" which are precisely localized in the cerebrum and indicated by perceptible enlargements in the brain or skull. This doctrine, both as originated a century ago by Gall and Spurzheim in honest endeavors to explain the specializations of functions of the brain, and as later commercialized as Phrenology, is obviously based not only on incorrect neurology but also on false psychology, as we shall see more fully in later chapters.

THE OPERATION OF THE NERVOUS SYSTEM AS A WHOLE

We have illustrated roughly the possible distribution of nerve impulses. According to the prevailing theory just what effectors will be aroused depends upon the conditions at the synapses. Certain synapses in the course of an impulse from any particular receptor, will be found to be "open," that is, to offer little resistance as a result of one's inherited organization. In this way, the unlearned or *instinctive* reactions, which involve mainly, and probably wholly, connections in the spinal cord and midbrain, are accounted for. The relative openness of other synapses, particularly of those in the cerebrum, is determined by the experience and learning of the individual. In fact, all learning—according to this theory—consists in the modification of synaptic connections by the passage of nerve impulses across them. The exact nature of the nerve impulse, now supposed to be an electro-chemical process, is not known, nor is the character of the changes in the synapses brought about by the passage of impulses. A fundamental assumption of physiology, however, is that the transmission of nerve impulses does change the condition of the synapse in a way that makes subsequent passage more easy, certain and prompt. This change brought about by exercise is sometimes spoken of as lowering the resistance, causing greater openness of the synapse, or in other ways. All of these expressions imply the same general hypothesis.

Diffusion of Nerve Impulses.—The nervous system is so organized that an impulse, initiated at any receptor, may make its way to many, perhaps to all, reactors. If all switches (synapses) were open, any stimulus might produce all the responses of which the body is capable. An approximation to such diffuse reaction can be shown in a simple experiment. If we prick the foot of a frog with a stiff hair or a pin, the usual response is a slight jerk of the leg. A second stimulation of the same spot will provoke a bigger response of the leg; a third stimulus may bring the other leg into action, and further stimuli will show a spreading of response until the whole organism, probably every muscle and gland, is involved. The diffusion of response is secured more readily when a bit of strychnine, which lowers the resistance of synapses, is injected before the experiment is begun. Such diffusion of nerve impulse is, of course, not usually the case and never occurs except under extraordinary conditions, but it proves the general statement that from each and every receptor, pathways may be made through the nervous system to each and every organ of response.

The Convergence of Nerve Impulses.—The organization of the nervous system which has been sketched provides not only for the possibility of the passage of a nerve impulse from one receptor to almost all reactors, but for the convergence of impulses from many receptors upon one effector. That convergence, as well as diffusion, is provided for may be illustrated by an experiment upon a frog. A very gentle prod on the foot with a stiff hair may elicit no response, but when a slight sound is made simultaneously, the foot may jerk as it would for a more intense stimulation with the hair. If these two stimuli prove insufficient, a small flash of light added to the combination may cause the foot to jerk. The nerve impulses aroused in different parts of the body seem to have come together and combined their energy on the muscle in the foot. A light, a sound and a prick on the foot are about as unrelated as any three stimuli could be, and if the impulses from these can be converged on the same effectors, it is probable that nerve impulses from any or all receptors may find their way to any particular effector.

Indeed, this would follow as a necessary corollary of the fact of diffusion of impulses previously illustrated *i.e.*, the fact that from one receptor impulses may reach any given effector.

The mechanism of convergence is illustrated in Figure

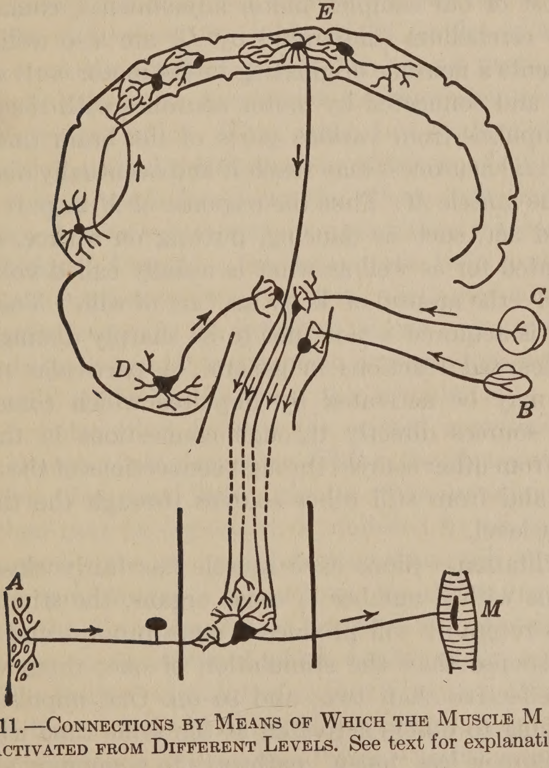


Fig. 11.—Connections by Means of Which the Muscle M May Be Activated from Different Levels. See text for explanation.

11. Suppose muscle *M* to be in the foot. It may be aroused by a stimulus, such as a pin prick which affects sense organ *A* in the vicinity of the muscle. The reaction would be a reflex. Impulses received from *B*, the ear, or *C*, the eye, by means of connections in the mid-brain level may also

discharge into *M*. In everyday experience this occurs in many of our bodily adjustments brought about by things seen or heard. When we are startled by sudden sounds, when we shift our equilibrium on observing an obstacle or halt at a strong odor, the mid-brain level is involved. In most of our complex motor adjustments, connections in the cerebellum (illustrated by *D*) are also utilized. *E* represents a neurone originating in the motor cortex of the brain, and connected by motor neurones with the muscle *M*. Impulses from various parts of the brain (indicated by several neurones) may reach *E* and eventually discharge into the muscle *M*. Thus the response of *M* as part of any learned act, such as dancing, putting on a shoe, etc., is accounted for as well as what is usually called voluntary control—the arousal of *M* by an "act of will." Voluntary action is acquired action, not to be sharply distinguished from learned reactions in general. A particular muscle, then, may be activated by impulses which come from many sources directly through connections in the first level, from other sources through connections of the second level, and from still other sources through the third or highest level.

Facilitation.—Since each muscle has fairly close connections with a number of sense organs, the stimulation of two receptors will produce a more prompt and vigorous response than the stimulation of one; three will be more effective than two; and so on. One impulse adds something to others activated at the same time when all have more or less "open" pathways to a common effector or group of effectors. This is the phenomenon of *facilitation.* The neurologist is often able to select at different points on the body the several sensory endings from which impulses lead rather directly to a particular effector; that is, he knows where to apply stimulation to secure relatively pronounced facilitation. The possibilities of facilitation are shown in Figure 11 and everyday life affords other true, but less precise examples. If one is frightened while walking alone at night, one tends to speed up a little on slight stimulation; a crackle, the chirp of a night bird, the sudden perception of a dark object may stir one to flight. The sight of food on the table added to the odors and sounds from the kitchen, makes our hunger more acute. We shout at the horse, in addition to other stimulation, to get the greatest action. Thus, when two or more stimuli, each having a similar influence on common effectors, are given at once, each facilitates the others with the result that the response is more certain, prompt and vigorous.

Inhibition.—Usually a resting muscle is in a state of partial contraction or *tonus*, as it is called; and so far, we have considered only the influence of one or more stimuli in producing a greater contraction or a positive response. An equally important function of a stimulus is to arouse nerve impulses that depress the partial contraction, or tonus, or suppress it altogether. This is the phenomenon of *inhibition*. The usual jerk of the leg when an animal's toe is pinched may be depressed or inhibited by stimulating, at the same time, an appropriate spot on the other leg.

When the forearm is raised from the elbow one set of muscles, the biceps, contracts, whereas the opposing set, the triceps—contraction of which would conflict with the pull of the biceps—is inhibited so that it relaxes. Inhibition is more than a mere blocking of a response; it involves a positive reduction or cessation of the activity or tonus previously existing. Inhibition is quite as much a reaction to definite stimuli as contraction.

Coördination.—In nearly all reactions from the simplest to the most complex, both facilitations and inhibitions are involved. In such an act as picking up an object hundreds of nerve impulses are distributed to muscles of the head, trunk, legs, arms, hand and fingers. Some of these impulses cause muscular contractions, others inhibitions. The fact that the act of picking up the object goes on smoothly and harmoniously means that a high degree of coördination of nervous impulses has taken place in the nervous system. The nervous system is therefore often spoken of as an apparatus for *organizing* and *coördinating* nerve impulses. When thrown into action, each muscle by means of the connection of its sensory nerves with the central nervous system tends to innervate many other muscles, some to increased activity, others to diminished activity. The innervations from one muscle are coördinated with those from other sources so as to produce an effective response. Were the impulses not so organized in the central nervous system, the reaction would be a spasm of many unrelated responses instead of a nicely coördinated response which it usually is.

Integration.—The type of coördination brought about by the central nervous system is one which tends to make the organism respond as a unit rather than as a collection of unrelated parts. Although this unity of response is sometimes broken down (by drugs, disease, shock, etc.) it is characteristic of normal reaction. At least, there is a tendency toward *integrative action.* Integrative action is unifying action. The organism's activity, in other words, tends to be organized into a unified whole of related parts. This fact may be clarified by illustrations. A young chick, when first presented with grains of wheat, pecks with fair accuracy, and in pecking from a standing position most of the body is engaged. Unless the many movements were beautifully coördinated the chick would lose its balance, or fail to guide the beak to the right place or fail to open it at the right time, or start to straighten up before the wheat was reached. To carry out the act, all of the subordinate reactions must be highly integrated. Facilitations of some and inhibitions of other responses are combined into a working whole. The typical reaction even of a newborn chick is remarkably well integrated, possibly as the result of inherited characteristics of the nervous system.

In acquired responses the same integrative action is found. When a man catches a baseball, not only are many muscles of the arms and hands engaged, but also muscles of the eyes, neck, trunk and legs, changes in breathing and often other internal activities are found. To catch the ball, all of these must play properly their part in a unified whole adjustment. They must be integrated. Ofttimes the "muff" of the ball is due to some very small divergence of eye or foot or finger. Well perfected reactions are highly unified. In learning to skate, dive, write, indeed, in acquiring all abilities, the nervous system progresses toward an integration of many constituent reactions. No characteristic of nervous action is more important than the tendency to unify the nerve currents to produce an effective total response to a stimulating situation.

Integrative Action in "Attention."—The integrative action of the nervous system explains also the behavior usually discussed under the term attention. Attention is not a power or faculty but a term used to cover certain facts, as follows: (1) The organism is usually adjusted as a whole to some one thing or event, that is, to some one situation. This adjustment includes proper fixation of the sense organs and of the body generally to receive most fully the effects of the stimulus. (2) The situation to which one is adjusted—toward which one takes the "attentive attitude"—becomes more highly conscious than anything else. This situation is the one to which some further response—approach, grasp, avoid, or observe further or neglect, if the situation does not possess the importance it promised—will be made. This situation which is at the "focus" of consciousness, is the one of supreme significance at the moment. That the organism, as a whole, is oriented toward the "object of attention" and that this object becomes conscious in the highest degree to the subordination of awareness of everything else, can be explained only by saying that the action of the system as a whole, including those mechanisms which underlie conscious experience, is integrative action. Due to properly coördinating facilitations here and inhibitions there, we become conscious not of a thousand and one different and unrelated things each in equal degree but, on the contrary, we become aware chiefly of some unified impression.

The whole discussion of the action of the nervous system leads to the significance of integrative action. All other characteristics are subordinate to this tendency of the system to produce an effective, total response to the dominant situation.

Summary and Conclusions

All human activity may be explained as reaction to stimuli. We make movements, secrete glandular substance, sense, think or otherwise are active mentally only as the result of stimulation. All activities—motor, glandular and conscious—are the results of reactions of the organism. When we say the muscle contracts, the gland secretes and the brain thinks, we are really not telling the whole story. Normally, our movements, glandular secretions and conscious activities largely involve the organism as a whole. Due to the structure and functions of the nervous system, the reactions of the organism, moreover, tend normally to be coördinated and unified or integrated.

Most of the complex reactions with which psychology is concerned moreover are made not to a single and simple stimulus but to a combination of forces. Prominent among the forces are the activities going on within the person at the time. The activity of any bodily mechanism serves as a partial cause or stimulus for further activity. Thus the behavior of a man is determined by the combined and coördinated effects of what we may for convenience divide into external and internal conditions or activities, including in the latter both conscious and unconscious activities.

The man strolling along the street or attending a concert, the child at play or in school, is subjected at once to innumerable stimuli which affect eye, ear, nose and skin, to influences from many internal bodily conditions, from the activities of muscles and glands, which he may or may not realize and to influences from many "mental" activities resulting in what are termed his percepts, ideas, feelings or purposes. All of these influences, taken together, constitute the situation which leads to a response.

The term *situation* or *total situation* is commonly used, instead of stimulus, because it contains a better suggestion of the complexity of events which normally is found to precede a response. *Situation* means, strictly, a complex group or pattern of stimuli. To avoid monotony the term stimulus will be used interchangeably with situation in this book, however, with the understanding that both words refer to a highly complex state of affairs.

QUESTIONS AND EXERCISES

1. Does any stimulus affect more than one kind of sense organ at a time? How about smoke? Name others.

2. What stimuli and sense organs are probably used during the first practice periods in playing the piano? What stimuli become more, what ones less, important as a person becomes more proficient in playing the piano?

3. What sense organs are most indispensable in the daily life of a person living in a modern city? What ones are least essential?

4. Compare the control of the activity in a human being with the control of machinery in a shop operated by electricity. What corresponds to the stimulus, the sense organ, the nerves and nerve impulses and the reacting mechanisms? In what respects are the activities of a human being different from those of a complex machine operated by electricity?

5. If the reaction hypothesis were accepted would it follow that mental activities could not be a stimulus as well as a response? Compare mental activities with muscular activities in this respect.

6. Draw from memory rough outlines of the three levels of reaction.

7. Which of the three levels is probably involved in such reactions as: (a) a young baby spreading the toes fanwise when the sole of his foot is stroked; (b) a baby crying when frightened by a loud noise; (c) a baby sneezing when dust gets in his nose; (d) a baby carrying a small object to his mouth; (e) a baby getting excited when he sees his mother carrying the "bottle"; (f) a baby waving when someone says "Bye-bye!"

8. When electric currents are properly applied to certain portions of a dog's cerebrum, the animal may move his front foot. Draw a rough diagram showing what nerves are probably involved.

9. Define each of the following terms; neurone, synapse, diffusion of impulses, convergence of impulses, facilitation, inhibition, integrative action.

10. Consider a child just beginning to learn to write and another child who has had several years of practice in writing. In which child are the activities most fully integrated? Cite certain activities which show imperfect integration.

11. In what respects may the nervous system be compared with a telephone system? In what respects do the operations of the two systems differ?

12. Give some illustrations in which general conduct, including thinking, has been influenced by a temporary or long lasting physiological condition.

13. If it is true that certain glandular abnormalities may result in fidgeting and inattention in a child, does it necessarily follow that *all* such symptoms are due to glandular abnormalities? What other factors might cause similar behavior?

14. On which of the following human characteristics are the en-

docrines mostly likely to exert an influence: speed of reading, quality of writing, muscular strength, bodily endurance, intelligence, emotional responsiveness, moodiness, vivacity.

15. What are some of the difficulties encountered in determining the relations between sections of the brain and consciousness? Could animals be used as subjects in such study?

16. Criticize the theory that traits of character such as a secretiveness, ambitiousness, etc., can be predicted from the sizes of lumps upon and depressions in the skull.

17. When it was stated that the brain tends to function as a whole did the author mean that every neurone is necessarily engaged in every response or merely that certain systems of neurones in all brain parts were engaged?

18. What differences or distinctions can you find between muscular and glandular responses on the one hand, and conscious reactions (consciousness) on the other? Are any of these distinctions necessarily antagonistic to the idea that conscious activities are reactions?

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CHAPTER III

HEREDITY AND GROWTH OF ORGANS AND FUNCTIONS

In the preceding chapter we observed that, for the purpose of studying behavior, a human being may be conceived of as an organism made up of receiving, connecting (or integrating) and reacting mechanisms. These mechanisms are bodily organs, and the terms receiving, connecting or integrating and reacting refer to the capacities or functions of the organs. To understand human behavior at any age, we need to know the origin and development of these organs and the functions which they possess.

PRACTICAL VALUES OF PREDICTIONS OF GROWTH

Individual Differences Are Apparent at Birth.—If we had before us a dozen newborn infants, it would soon be apparent that, while they possess the same organs, they nevertheless show marked differences. In the size, weight and general appearance of the body these infants differ from each other. In fact in any anatomical trait one might single out such as color of the eye or shape of the nose, individual variations would be found. Accurate tests of functions would also reveal differences. In the sensitivity of the eye or other sense organs, in the conductivity and modifiability of the nervous system, in the speed and vigor of muscular response, in the secretory capacity of glands, individual differences would be present at birth.

Individual Differences More Conspicuous Later.—Suppose that the same dozen individuals could be compared again at the age of ten years. Each would differ greatly from what he was at birth. Height and weight would be much greater and general appearance would be vastly different. The sensitivity of the sense organs would probably be greater as would also the general efficiency of the nervous system, the speed and vigor of motor response and the functions of some of the glands. These children, now greatly changed from their infantile selves, still differ from each other. In fact the variations among them are more striking than they were at birth. The differences in height, weight, appearance, vigor of muscular response are, in terms of familiar measures, greater than they were before.

Questions to Be Raised.—These comparisons raise several problems of great importance to students of education. What is responsible for the growth of human organs and functions before birth? What causes the marked individual differences among infants born at the same time? Do similar influences control growth after birth? Are the individual variations among children at ten predictable from the differences found at birth? Indeed, can the make-up of a child at ten or of an adult be in any measure predicted before his birth?

Value of Ability to Predict Native Predispositions.—If predictions of the future development of a child could be made early it would be of tremendous value to those of us who are interested in education. If we could tell before a child is born what he would grow into, we could, if we desired, encourage the birth of those most suited to advance the interests of society and discourage the birth of others. At the least, we could be better prepared to administer the bringing up of each child in the way most fruitful for him and for society. Even if we could foretell from the nature of a child at birth, or at five or even ten years of age what course his future development would tend to take, we could improve his education by adjusting it to his particular predispositions. For education and nurture to be most fruitful, we need to know not only what a child's predispositions are but also what ones, if any, can be changed, how they can be changed and within what limits they can be changed for the better. If these facts were available, we could save time and avoid disappointment by relinquishing effort to change those traits, if any there are, that will run their course despite us, and we could increase our service by concentrating on those factors which are susceptible to improvement through the control of education and nurture.

Problems of vast importance to students of education, then, are those of discovering means of predicting development and of finding the degree to which the growth of various important human traits may be controlled by education, diet, stimulation, exercise and other influences which can be applied during the course of life.

The Terms Heredity and Environment.—The problem to be raised in this chapter is the old question of heredity and environment. By *heredity* is meant the influence of factors inherent in the child himself from the time he was conceived. Hereditary influences are intrinsic or innate. Under *environment* is included every influence brought to bear upon the human organism from the time of the beginning of life. The nourishment, the surroundings, the disease germs influencing the child before or after birth, the accidents, education and experiences encountered after birth are covered by the term environment. Environmental influences may be termed extrinsic or external in contrast with the intrinsic or innate factors of heredity.

The Nature of Heredity Influences.—We may begin with the general statement that, before a person is born, we can predict within certain limits what his structures and functions will be. Such predictions are made possible by the results of extensive studies of two sorts.

(1) Studies of the character and behavior of the seed from which human beings grow.
(2) Studies of the resemblances between an individual and his relatives, especially his ancestors.

The Physical Basis of Heredity.—The "seed" from which a human being grows is composed of germ cells. Human life is begun by the process of fertilization, which is the union of male and female germ cells. The male cell unites with the female cell to form a fertilized egg cell. With the fertilization of the egg cell, growth begins by a complicated process of cell division, in which elements from both parent cells participate in substantially equal measure in the average of many such unions but in varied degrees in any one case. Some of the elements resulting from this complex process become the basis of the growth of bodily organs and functions and some are perpetuated as germ cells within the growing organism. The process of fertilization, then, results in two things, the growth of an organism of one or the other sex, and the perpetuation of germ cells characteristic of that sex. The substances which grow into the new organism and the germ cells therein contained may be called "determiners" or merely "elements," although more technical terms are often applied to them.

It is important at this point to observe not only that all organs making up the human body issue from the determiners in the union of male and female germ cells—that is, the fertilized egg cell—but also that the germ cells which this new individual contains within himself likewise issue from elements in the parental germ cells and are not generated by the body of the new individual. The new individual contains or carries germs cells but he does not manufacture them. They merely live and reproduce themselves within him (or her) somewhat like tiny unicellular organisms live in pools of water. The body does not make them, it merely provides the medium in which their life and reproduction may be sustained. The importance of this distinction will soon be apparent.

The Nature and Significance of Resemblances among Relatives

Types of Evidence of Human Heredity.—Each individual springs from germ cells that were, so to speak, merely housed in the bodies of the parents. The union of germ cells results in rapid growth of an organism. The structures comprising this organism are believed to be determined, at least within limits, by elements present in the fertilized egg cell. This is believed to be true chiefly for two reasons. First, in the case of simple organisms such as a certain much studied fruit fly, the elements, or rather certain groupings of them, can be observed under a microscope and their tendency to issue into certain bodily traits has been verified by observation. Second, in the case of human beings, the resemblances of offspring to each other and of offspring to parents are such as to suggest strongly that many human traits are to some extent predetermined in a similar way by elements in the human germ cell. While we do not know very much more than has just been said about the human germ cells, we have learned a good deal about human resemblances. We cannot predict what the particular characteristics of a human being will be by examining human germ cells but we can, in some measure, forecast his nature by studying his relatives.

Evidence of Resemblances among Relatives.—It is obvious to everyone that, in general, individuals resemble their relatives in appearance more than they resemble each other. It is true, furthermore, than on the whole individuals resemble close relatives more than distant ones. Brothers or sisters are more alike than are cousins, and near cousins show greater similarities than distant cousins. Individuals also resemble their parents more than their grandparents and still more than their great-grandparents. Anyone can think of exceptions to these statements but they nevertheless describe the general rule. Indeed, one can detect family resemblance such as unique facial characteristics, a tendency toward unusual height or weight, or swarthy complexion in a number of generations. The further back you go, on the whole, the more the family characteristics fade out until at length they are lost in the variety of characteristics which comprise the human species in general. Predictions made from many generations back, then, can be little more definite than the statement that the expected infant will be a human being, possessed of some degree of those traits which characterize man from other species. The most definite predictions, on the other hand, apparently can be made from knowledge of the characteristics of the infant's *nearest* relatives.

Methods Used Determining Resemblances.—Many studies have been made to determine more definitely the degree of resemblance between different relatives in various traits. The most useful of these studies have utilized two devices: (1) accurate measurements of the trait and (2) accurate statistical methods of determining and expressing the resemblances. Physical traits like height or certain features of the shape of the skull can be quite accurately measured. Once the traits are measured, the next step is to apply the statistical method of *correlation.* The method of correlation is a reliable device for determining and expressing resemblances. We shall not try to tell how a correlation is determined but merely attempt to indicate roughly what it means.

The Meaning of Correlation as an Expression of Resemblance.—Consider the degree to which miscellaneous human beings of a given age resemble each other! Well, they resemble each other, in general, only by having common human traits. Let this general resemblance be represented by zero. Think, now, of perfect resemblances as between a number of imaginary persons who are so nearly identical that you cannot see or measure any differences between them. Let such substantially perfect resemblance be represented by 1.0. Resemblances can now be indicated by a series of figures running between these extremes 1.00, .90, .80 and so on down to .00. These figures are called *coefficients of correlation.*

Resemblances among Relatives in Terms of Correlations.—The degrees of resemblance among different relatives are suggested by the following correlations.

CORRELATION OF	COEFFICIENT OF CORRELATION
1. Identical twins	.90
2. Twins, all kinds mixed	.75
3. Brothers and sisters excluding twins	.50
4. Children and parents	.40
5. Cousins	.25
6. Grandparents and children	.15

"Identical" twins while not really identical resemble each other greatly and tend to retain these similarities throughout life. But, among twins of all kinds, of the same and opposite sex together, the resemblances are appreciably less. Siblings (or offspring of the same parents) show a resemblance roughly midway between zero and perfect correlation; and cousins are halfway between the figures for siblings and zero correlation.

General Resemblances of Offspring and Parents.—From our point of view the most interesting figure is that which represents the resemblance of the child to his parents. From what we know about parents, what can we predict about their actual or contemplated offspring? The correlation is .40! This figure means, at least, that there is a considerable resemblance. "Like tends to beget like." Yet the resemblance, even in the long run, is far from perfect, if for no other reason than that each child springs from the germ cells of both parents. If you average the traits of both parents yielding what may be called a "mid-parent," and determine the resemblance of such mid-parents to their offspring, the figure will be larger, about .50. This is a considerable resemblance. It means, practically, that the characteristics of children in the long run can in appreciable degree be foretold by knowing exactly the traits of both parents. But, the other side of the case should be noted, too. There is just as much about the characteristics of children which we cannot tell from knowing the traits of the parents. The correlation, at any rate, is about midway between zero, which means the general degree to which unrelated children resemble each other and substantial similarity of identical twins.

The Influence of the Germ Cells on Resemblance.—The fact that children resemble their parents only in some degree, instead of perfectly, does not prove that a child's traits are not inherited or only half inherited. The germ cells from which an individual grows, it will be recalled, are not manufactured by the parents' bodies. They are not reduced miniatures of what the parents are. They are not affected in specific ways by what the parents do or become. Habits, skills, abilities, ideals, interests formed by the parents are not transmitted to their germ cells for the reason that these organisms are merely housed in the parent's body where they carry on their own existence. The germ cells in your body are determined not by what you are or do but by the elements in the germ cells of your two parents at the time you were conceived. The germ cells of each of your two parents, in turn, were derived from the cells of their two parents, and so on back indefinitely. The result is that to the germ cells from which anyone springs the two parents contribute one-half, the four grandparents one-quarter, the eight great-grandparents one-eighth and so on. If you add these fractions up you find that they approach one, but never quite equal it. There is always half of the remaining amount to attribute to still more remote ancestors. Since one's parents contribute only one-half of what one inherits in one's germ cells, it should be expected that one's resemblance to one's parents would only be partial. Fully to account for your inherited characteristics you must sum up your resemblance to all of your ancestors.

Predictions concerning an Individual on the Basis of Knowledge about His Parents.—But let us consider further the practical significance of the resemblance of children to their parents, which is the greatest in the ancestral series. It is great enough to be significant when we deal with averages for many children, but how useful is it when applied to a particular child? To illustrate: before you are two particular parents. They are both of exactly average height for their respective sexes. They have one child. What can you predict about the height of *this* child? Will it be average, or below or above the average of that sex? This is a practical question of prediction.

Variations among the Offspring of the Same Parents.—Well, we cannot say for sure what a single offspring's height will be. We could be sure only if the correlation between parents and offspring were perfect; but it is not. The correlation found, moreover, does not mean that all children resemble their parents in an equal, moderate degree. It is rather the result of the fact that different offspring resemble parents in different degrees, and that the average of these resemblances is only a moderate one. At the one extreme are children who grow up very much like the mid-parent; at the other are children who become very different, and between these extremes are found all the other children with the majority showing a moderate resemblance to their parents. Now, when you ask us to predict the height of a particular child from knowledge of his parents, you have asked a difficult question because we do not know whether this child is one that will resemble the parents the most or the least

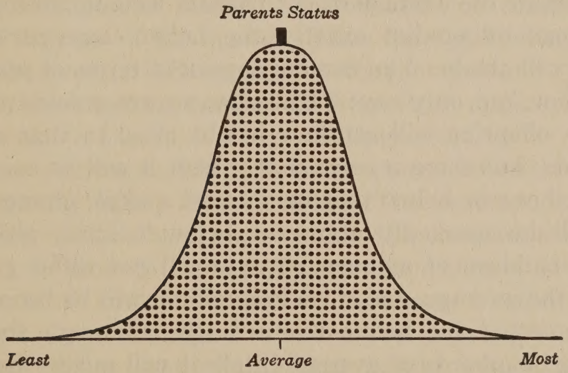

FIG. 12.—HYPOTHETICAL DISTRIBUTION OF OFFSPRING OF TWO PARENTS OF AVERAGE STATUS. Each dot represents one offspring. The figure illustrates roughly the fact that the offspring of a given pair of parents will not all be the same but will vary over a considerable range as shown. See text for discussion.

or in some intermediate degree. The offspring of parents of average height will tend to cluster about average height, but they will be scattered between two extremes, a greater and a less height, as indicated in Figure 12. As the figure shows, the further you depart, either higher or lower from the average height of the parents, the fewer offspring you will find.

Predictions concerning a Particular Child Must Be Made in Terms of Probability.—The fact that the offspring of the same parents will vary considerably above and below the average of the parents' height, means that you cannot predict exactly the height any particular child will attain. You can only speak in terms of *probability*. You can only say: "The chances are *greatest* that a single offspring will attain a height close to that of the parents; but there is *some* chance that it will be considerably above or below that height and a *slight* chance that it will be markedly above or below." Thus, although most children of average parents will not differ greatly from the average, one child in a million will be far above, and another far below the average. Although the offspring of parents of average intellect will mostly be near the same average brightness, one child in a billion probably will be a sparkling genius and another a helpless idiot.

Galton's Law of Regression Further Complicates Prediction.—Prediction of offspring's traits from knowledge of their parents is made even more complicated by a fact demonstrated by the eminent Sir Francis Galton, a pioneer investigator in this field. Galton found that if both parents are above (or below) the average of the general population in a trait, like height, the offspring will be an array, the average of which is nearer the general average than the average of the parents. Tall fathers, who average 72 inches, were found to have sons who averaged 70.8 inches; short fathers who averaged 66 inches were found to have sons who averaged 68.3 inches in height. The offspring "regress" toward the average of people in general. This "Law of Regression" is not due to any mysterious force but merely to the fact, mentioned above, that a child's inheritance comes only in part from his parents; it comes almost equally from more remote ancestors. If you go far enough back, one's ancestry comes to be approximately the average of the species for the reason that it will include an immense number of persons of all sorts. Average "all sorts" of people and you come close to the average of the species. Thus the "pull" back toward the average is due merely to the fact that one's germ cells in the long run are derived from those of all sorts of people who make up an army of ancestors.

Some Ancestral Lines Remain above or below the Average for Many Generations.—The statement that offspring of parents above or below the common average in a trait tend to regress toward the common average may seem to contradict the fact that some families have a long history of marked superiority or inferiority. Take the case of the notorious Kallikak family, whose history for a century and a half has been traced. The records of four hundred and eighty members of this family have been studied. Of these, one hundred and forty-three were so far below the average as to be classified as feebleminded. Many of the others were probably dull and only a few were as good as or better than average. Many were known to be sexually immoral, thirty six were of illegitimate birth and twenty-four were chronic alcoholics. Contrast this dark picture of the Kallikaks with the bright history of the Edwards family. Among 1394 identified members of this family traced from 1900 back to 1703, there were thirteen college presidents, sixty-five college professors, sixty physicians, a hundred clergymen, a hundred lawyers, thirty judges, seventy-five prominent authors, seventy-five army or navy officers, eighty prominent public officials and many other successful bankers, business men, landowners and the like. Here then is one family which, on the whole, remained well below the average in mentality for nearly a century and a half and another which remained well above mediocrity for two centuries. Certainly these two pictures do not seem to illustrate very well our previous statements that there is marked variability among the offspring of the same parents and that there is a general regression toward the average. But let us look into all the facts involved.

Prolonged High and Low Levels in a Family Are Exceptional and Largely Due to Selective Mating.—In the first place these are exceptional, rather than typical pictures. There are some families which hold up or remain down like these for considerable periods, but the majority of families, when traced back, show a greater mixture of high, mediocre and low. Very few able doctors, lawyers or statesmen now living can point back to a thousand equally exceptional ancestors. The distinctions between the Kallikaks and Edwards, as pictured above, are probably exaggerated, moreover. All of the Edwards were not equally superior. Some, indeed doubtless had very ordinary minds. Some of the Kallikaks were much superior to the average Kallikak, too. Indeed, it is highly probable that some of the Kallikaks were endowed as well as some of the Edwardses. The best Kallikaks may have seemed worse because their education, opportunities and environment were poor. Some of the Edwardses may have seemed better than they were because of the advantages of education, wealth, social position and other phases of their "social inheritance." There are many men of average mentality who work at common labor and who marry women duller than themselves, and other men of average minds who have inherited and who operate a substantial business and marry women of distinctly superior intellectuality. Here, we have another very important factor—*selective mating*. The Kallikaks tended to stay down because their nature and environment together produced a tendency to continue mating with poor stock. The Edwardses on the other hand continued, on the whole, to mate well. The surest way to keep a family up is to see that its members mate with superior people; the surest way to keep it down is to have it continue to mate with inferior stock. Finally, it may be said that every exceptional lineage will lose its distinctive character if it is traced back far enough. The Edwards family's distinction is inconspicuous if you go beyond 1700 and the Kallikak family began during the American Revolution with the union of a feeble-minded girl and a young soldier, Martin Kallikak, who was apparently not dull, however indiscreet. The family at this time was not all bad, but only half bad. Even the most striking of the exceptional families, then, tend in time to regress toward the common herd, unless prevented by rigidly selective mating. Since matings are rarely rigidly selective in a family for prolonged periods, most exceptional individuals show an ancestry that approaches mediocrity. They will probably also beget a progeny which will not only be varied but which will gradually regress again toward the average. This is the general rule; which will show itself in time unless it is prevented by rigidly selective mating.

Offspring of Exceptional Parents Are More Likely Also to Be Exceptional if the Parents Were Preceded by a Long Lineage of Exceptional Ancestors.—This statement is really a corollary of the facts just stated, namely that a person secures only about one-half of his inheritance from his parents and the other half from his entire line of more remote ancestors. If the parents were preceded by fifty generations of superior ancestors, their offspring are more likely to be superior than if they were preceded by only two generations of superior forbears. Likewise parents immediately preceded by many generations of average or inferior ancestors are less likely to have superior children than parents whose corresponding ancestors have been superior. Thus, it becomes even more obvious that knowledge of the parents alone is insufficient for a very reliable prediction of the inheritance of a particular child.

Prediction of Offspring's Traits from Knowledge of Parents Alone Further Complicated by "Alternative Inheritance."—Prediction on the basis of knowledge of immediate ancestry alone is complicated by still another fact. Certain traits, such as color blindness (inability to see red and green normally) tend to be inherited on an "all or none" principle which may result in its being in a parent's germ cells without being obvious in his body. Thus if a color-blind man mates with a normal woman, the daughter may have normal vision, thus showing what is called the "dominant" trait, but carry in her germ cells the determiner of color blindness, the "recessive" trait. The recessive trait may make its appearance in the daughter's son, although examination of the daughter's vision would have given no inkling of it. The facts of "alternative inheritance" which are too complicated to review here further would make possible prediction of the appearance of such traits only were knowledge of the color vision of several generations available. The fact that there are a few such traits adds one more element of indefiniteness to predictions of the characteristics of a child's nature from knowledge of his parents alone.

Summary and Conclusions.—A survey of some of the known facts concerning the physical basis of heredity and the character of resemblances of a child to his parents and other relatives, reveals a rather disconcerting complexity of factors at work. Let us try to review the facts most significant for our practical interests as prospective educators and parents.

(1) The germ cells, whose union initiates the growth of a child, are believed to contain elements which predetermine, within certain limits, the structure and functions of the human organism.

(2) The germ cells are continuous from generation to generation and are not manufactured anew by each individual. They are housed in rather than generated by an individual.

(3) The germ cells are continued from generation to generation by a process of reproduction which results, roughly, in an average contribution of one-half of their inheritance from the immediate parents and the other half from the entire preceding line of ancestors.

(4) Studies of resemblances among relatives indicate that in many traits subject to measurement, children, in the long run, resemble their parents in a measure roughly midway between the resemblance found between pairs of identical twins and that found among human beings in general.

(5) Predictions of the traits of a *particular* child on the basis of knowledge of the child's parents are not very definite and can be made only in terms of *probability* for the following reasons.

(a) Offspring of a given mating instead of being the same vary considerably from each other.

(b) Only half of a child's heritage is reflected in the parents alone; the other half goes back many generations.

(c) Certain traits like color blindness may be inherited by a child when not revealed at all in the structures and functions of the immediate parents.

In conclusion, we must say that neither by studying the parents' germ cells nor by measuring the traits of the parents' structures and functions can we now secure as reliable predictions of a child's native predispositions as we should like to have in educational work. The facts obtained from studies in these two lines are important and suggestive but insufficient. We must turn to other methods. We shall, in particular, attempt to see what may be learned from studying the process of growth, before and after birth. In particular we shall be interested in certain cases in which, as the result of accident or deliberate experiment, individuals have been subjected to exceptional environmental influences during the period of growth. It is of vast importance to know not only what the course of growth tends to be in the typical case, but how it may be influenced by education, opportunity, accidents and nurture. Studies of the type just reviewed do not reveal these factors clearly. The kind of prediction needed in education is one which enables us to take both heredity and environment into account.

GROWTH CURVES OF STRUCTURE AND FUNCTIONS

The Methods of Investigating Growth.—The most promising method of determining the nature of growth and the influences which modify it for better or worse consists in making a series of consecutive measures of a single individual from the earliest to the latest possible moment. When a person is carefully measured by reliable means at intervals, a curve or graphic picture of growth can be drawn. Such a curve indicates the general trend of an individual's growth. When curves are obtained from many individuals measured in the same way, highly illuminating comparisons may be made. The general characteristics of growth of a given trait can be determined and individual variations can be easily perceived. If the environmental factors such as diet, activities, disease, etc., influencing each individual, are known at all times, they may be related to characteristics of an individual's curve of growth. It would be possible, by following such methods of experimentation as were described in Chapter I, to introduce at times marked variations from the normal diet, exercise, education, incentives and other extrinsic factors and to observe what variations in growth, if any, result. By all of these means, it would be possible to determine the validity and limitations of predicting growth from a given moment, say at the age of six, to maturity on the basis of the developmental trend shown prior to that time.

Although this field of investigation promises to be most fruitful of results for education, it has only recently been occupied extensively. Only a few growth curves have been determined for long periods of life and many important traits have not been measured consecutively at all. The results available are so valuable, however, that we must present them in some detail. In order to give as complete a picture of growth as possible, we should begin with development from the inception of life to the time of birth although the data for this period are decidedly meager. Prenatal growth, indeed, is peculiarly suggestive of the early beginning of developmental trends.

Prenatal Growth.—Before the time of birth, a child is unusually well protected from external influences. Although growth is dependent upon nourishment obtained directly from the blood stream of the mother, and is affected by the character of the blood, the unborn child seems to have a first claim upon the sources of nourishment, so that insufficiency seems to affect the child less seriously than the mother. It appears, in fact, that only rather extreme influences upon the mother such as severe illness, emotional disturbances, malnutrition, alcoholism and the like affect the child seriously through impoverished or poisoned blood. The notion that the fears, desires, ambitions and other mental occupations or physical activities of the mother affect the child's mind, body or character in direct or specific ways is quite discredited. Only as such experiences or occupations are profound enough to influence the mother's blood stream do they affect the child. The child may also be affected directly by infectious disease and by injuries before birth. But it is believed that few other extrinsic factors do influence the child's prenatal development. Since only such extreme factors as these influence the child before birth, it seems incredible that environmental factors could account for the striking range of individual differences found among newborn infants. Given favorable conditions prior to birth, differences among infants will still appear; differences that reveal variations in the heredity predispositions existing at the genesis of life.

At the time of birth, however, almost no trait, not even the color of the eyes, is fixed in its final form. Growth is still going on; the eyes rapidly become a deeper blue, the bones gradually lengthen, the body approaches new proportions. Are these changes which take place after birth, like prenatal growth, largely the result of inner growth which is usually called *maturation*, or are they now more largely determined by the fortunes of life, by diet, exercise, health, education and other influences provided by the much more variable and complex environment? Unfortunately, the answers to these questions, as far as they are known, vary with the characteristics. It will be necessary therefore to consider the problem in connection with each of several types of traits, confining ourselves in this chapter chiefly to certain anatomical organs and certain fundamental functions. We shall first give miscellaneous details about several representative growth curves and later attempt to draw up a series of principles concerning the nature of development in general.

The Growth of Anatomical Traits.—The growth of height may be taken as an illustration of the development of an anatomical trait. Beginning at approximately zero height an average boy has grown to about 20.3 inches at birth, to about 42 inches at the age of five, and to about 68.5 inches at seventeen or thereabouts when he reaches his maximum. Different individuals show various heights at each of these ages. Some grow less uniformly than others; some mature later than others. Despite these variations, however, there is a marked degree of uniformity in the growth of height in the typical cases. The uniformity is such that an individual who is relatively tall at birth or at five years of age is likely to remain relatively tall until maturity. Similarly one who is average or short at one time is likely to have been so before and to continue to be so thereafter. Curves of growth for different individuals, as shown in Figures 13 and 14, tend to have a fairly consistent rate. In general, the more rapid the rate, the greater the maximum height at maturity.

The Growth in Height Suggests an Hereditary Predisposition.—The fact that growth in height after birth tends to go on in such a continuous manner, describing a curve of rather consistent character, suggests that its *rate* is determined from within rather than from without. The fact that children tend to continue to grow in height at the pace shown at birth, also suggests that individuals inherit a disposition toward rapid, average or slow growth as the case may be.

It should be noted that the hereditary factor, however potent or slight it may be is merely a determining tendency or predisposition. A person does not literally inherit his height. He inherits merely a tendency to grow a short, average, or long body. Growth itself is necessarily dependent upon environmental factors. It goes on only when one has proper food, sleep, exercise and surroundings. Growth, literally, can be due neither to heredity or environment alone. It is the joint product of the two. It is the resultant of the interaction of nature and nurture. Maturation itself is really a response to stimulation. It is a response to such physical and chemical stimuli of many sorts. It is part of our nature to respond by growing.

Growth in Height Can Be Modified by Environment.—Whatever a person's hereditary disposition may be, growth may, within limits, be modified by environmental factors. The growth of height may be greatly retarded by injury to, or disease of the pituitary gland. In the case of certain diseases of this gland, growth may be greatly accelerated by administering doses of the drug secreted by this gland. These influences are, of course, extraordinary ones. Growth of the skeleton may be retarded furthermore by extreme variations in nutrition, exercise and perhaps in other ways. Yet, as far as we now know, marked variations from the general trend in growth of the skeleton are produced only by rather extreme and extraordinary variations from normal or typical conditions. A person's height then is in general largely an expression of an innate predisposition. Stated in other words, the growth of a child's height, provided he leads a reasonably normal life, can be little influenced by environmental

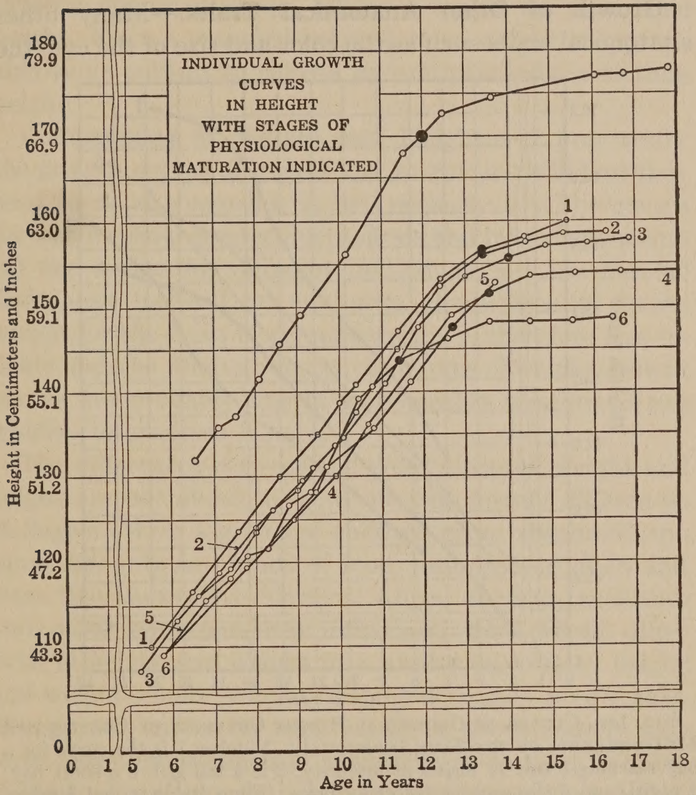

FIG. 13.—GROWTH CURVES FOR SEVEN GIRLS. The curves for the tall girl and for girl 1 are most regular. These two girls had a history of fine health. The other five girls were subject to illnesses and diseases more numerous and serious than the average. Their curves, especially the curve for 6, show minor irregularities. Even so, these curves show general trends quite clearly. The black circle indicates the beginning of pubescence. (From Baldwin, *The Physical Growth of Children.*)

factors. It can be deliberately modified only by rather drastic measures.

Growth of Other Anatomical Traits.—Many other anatomical traits such as the color and size of the eye, the shape and size of the pelvis, or ear or head, seem to be, like height, determined largely by maturation. On the other hand, the growth of such a trait as weight is considerably subject to variations in environmental factors. Extreme exertion detracts more from the increase in weight than from gain in height; a thorough rest may cause an

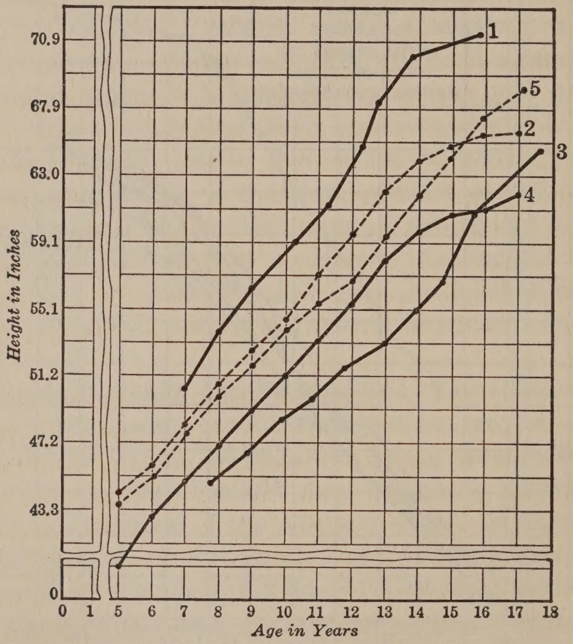

FIG. 14.—CURVES OF GROWTH IN HEIGHT OBTAINED BY CONSECUTIVE MEASUREMENTS OF THE SAME INDIVIDUALS. Number 1 is the curve for a boy reaching 5 feet 11 inches at maturity; 2 is a tall girl; 3 a short boy; 4 a girl, and 5 the average for many boys. (From Baldwin and Stecher. *University of Iowa Studies*, Vol. 2, No. 1, 1922.)

increase in weight without an appreciable influence upon height. Undernutrition and overnutrition, conditions of extreme health or illness, influence weight far more than height. From a practical point of view, weight is appreciably more subject to control by extrinsic influences than height.

Comparisons of Weight and Height.—If you study the growth curves of weight and height you will find they tend to differ somewhat in two respects: (1) The curves for weight show greater fluctuations and irregularities and (2) the curves for different individuals are less parallel and more inclined to crisscross. Predictions of future weight on the basis of present weight is therefore less reliable and the fluctuations in the curves of weight-growth curves are probably due in considerable measure, if not wholly, to extrinsic factors.

The differences between the determiners of weight and height are not absolute, however, but merely differences in degree. Were a group of children given absolutely the same amounts and kinds of food, exercise and sleep and were they subject to identical drugs, diseases, accidents and other environmental influences, they would differ both in height and weight in a similar way. Both height and weight would probably be about equally predictable. The growth curves for each would be about equally uniform. Such environmental variations as do tend to occur in life to-day obviously influence weight more than height but they do not entirely control it. Thus in both extreme cases, growth is jointly determined by hereditary and environmental factors.

Growth of Functions of the Sense Organs.—The sensitivities of the sensory mechanisms are fairly well developed at birth, although growth is rapid for two or three years thereafter. By the age of three, the organs are very nearly as sensitive to stimuli as they will ever be, although it is probable that very gradual growth occurs until a maximum is reached in the late teens. A similar curve of development is shown by the capacity to discriminate between stimuli; for example, between high and low notes, dark and light shades of gray, heavy and light pressure. The development of such sensory capacities seems to be determined largely by maturation rather than by experience. Diligent exercise produces at any one stage some improvement, but the limit is soon reached. If one's auditory acuity is poor, no amount of special practice will result in a high degree of acuity. People blind from birth, despite more extensive auditory experience, have as a group, no greater sensitivity than other individuals.

In making these statements, two sources of confusion should be avoided. The one is the case of defects of the accessory apparatus of the sense organ, for example, in the lens or muscles of the eye, which may be remedied or corrected, thereby improving the function of the organ without actually changing the sensitivity of the receiving cells. The other is the fact that special practice may result in very great ability to *interpret* impressions which the normal individual would disregard. The blind, by attending to the echoes from their footsteps, learn to detect accurately the presence of obstacles or doorways in a room, but this sort of learning does not imply an increase in sensitivity of the sense organs of hearing.

The functions of the receptors in the sense organs, then, are characterized by rapid growth, which reaches approximate limits very early, and which is little subject to influence by special exercise or other extrinsic factors now known.

Growth of Glandular Functions.—Little is yet known concerning the growth of the functions of many of the glands. Most of the glands seem to function actively from birth until death in normal people, although they may be subject to some measure of early maturation and late deterioration. Other glands show a quite distinct process of growth and decline. The pineal and thymus glands develop actively in childhood, when their functions are chiefly exercised, and die with it. The sex glands develop gradually, maturing at various ages, mainly in the early teens. Extraordinary conditions may influence the growth of the glands considerably. Thus a serious deficiency of iodine in water and food, as in some parts of America and Switzerland, may disturb the growth of the thyroid gland. Other forms of malnutrition, shock, disease or overwork may disturb the growth and functioning of any gland, but normally the development is little affected by variations in extrinsic factors.

Growth of Motor Functions.—The speed of muscular reaction—as determined by the time required for a muscle to respond to a sensory stimulus, such as a touch or prick on a finger, or as determined by the rate at which a response can be made "voluntarily" as in tapping with the hand—and the precision and steadiness with which a member can be controlled in a simple act—such as moving a pencil down a continuously narrowing groove—represent fairly elementary muscular functions upon which, among other things, the acquisition of skill depends. As children become older, their efficiency in these functions increases. Maturity is probably reached between fifteen and twenty.

An Experimental Study of the Influence of Intensive Practice on a Simple Motor Function.—That growth in the speed of sheer motor response is probably influenced but little by exceptional extrinsic factors is indicated by the following experiment. A group of 82 children from four to six years of age were given daily practice in tapping with a blunt pencil as fast as they could about five minutes daily for eighteen days. By this time they had reached a maximum speed. The 82 children were then divided into two groups equal in the average rate of tapping, which was 40.5 taps per minute. One group was then given highly motivated practice on every school day for a period of six months while the other group received no practice. Then both groups of children were given several days of tests. The average rate for both groups was identical, approximately 45 taps per minute. Both had progressed from 40.5 taps to 45 taps per minute. The untrained group had gained as much as the group which received intensive training. After another interval of six months, the two groups were again tested. Each gained for a few days but soon reached limits which were again identical. Thus it appears that the advantage of prolonged and intensive training produced no perceptible increase in the growth of this motor function.

At the time of each of the tests, individual differences in speed of tapping appeared. When the children had not practiced immediately before the tests, they gained somewhat but quickly reached their limit, and these maximal abilities were very different. During an interval of time growth went on which made possible greater speed. The rate of maturation was more rapid for some children than for others, however, so that after the interval, although intensive practice brought about some gain, a limit was again quickly reached and these maximal abilities were once more very different. Thus it appears that the rate of growth and the limit of ability that may be reached at any time are due primarily to innate factors. Special advantages of practice were insufficient to overcome the innate advantages for the reason that they were effective only within narrow limits and only temporarily. When the children were practiced to the limits of their ability, wide differences were still found. These differences seem therefore to be due to differences in native equipment.

Comparisons of Growth of Structure and Functions.—Such experiments show that functions may grow at various rates, reach various limits, and be subject to the same joint influences of heredity and environment as structures. It shows, furthermore, that a function such as rate of tapping may be just as largely determined by heredity as the bones which account for one's height. It shows that special environmental advantages, over the average or normal kind of life, may have no more effect upon the growth or final developmental limit of a function than of an organ. This digression is made for the reason that occasional scientific workers have hastily asserted that physical and mental functions could not be determined in any measure by heredity because they are not structures. Even if heredity influenced only structures it would necessarily also affect functions since functions are merely structures in action. Functions, in the last analysis, depend upon structure. But determinations of the growth of gross features of structure such as the length of the bones or the weight of the brain do not tell us much about the various functions of these organs. Hence it is necessary to consider functions separately.

It is true, furthermore, that to determine the relative influence of special environmental factors upon one function does not tell us what it may be on another. Thus, although the speed of motor response is little affected by special training, the force or strength of motor response is probably influenced considerably by intensive and prolonged practice, although here again, differences due to innate constitutional factors would be great.

Growth of Functions of the Nervous System.—The nervous system is a structure and like other organs its growth, incomplete at birth, pursues a fairly uniform course until it reaches a maximum in the late teens. Figure 15 shows an estimate of the course of growth of the gross weight of the brain which contains the neurones primarily concerned in learning.

Two fundamental functions of the brain are modifiability and retentiveness. According to the theory mentioned in the preceding chapter, modifiability and retentiveness are functions of the neurones and are due to changes which occur at the synaptic connections. Modifiability refers to the ease or rapidity with which such changes may be effected and retentiveness to the permanence with which such changes are preserved. Modifiability and retentiveness of the neurones are assumed to be basal to the capacity to learn.

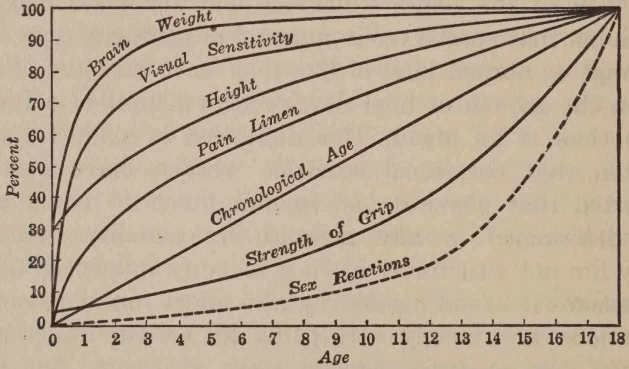

FIG. 15.—VARIOUS CURVES OF GROWTH. This figure indicates roughly the percentage of growth achieved at 18 years which has been completed in earlier years. The curves are only rough approximations; the curve for sex is a mere estimate.

Growth of Capacity to Learn.—Although the facts concerning capacity to learn will be presented in detail in a later chapter on intelligence it may be said at this time that this capacity appears to develop gradually from birth to maturity in a manner that strikingly resembles the course of growth for height in some respects but differs from it in others. It shows a curve differing in several respects from the growth curve for the brain as a gross structure. The functions depend upon subtle structures not fully depicted by mere brain weight. The capacity to learn appears to develop rapidly from the time of birth (according to extensive studies by Thorndike) until the late teens where it slows up considerably before it reaches a maximum level between the twenty-second and twenty-fifth year. It declines very slowly thereafter until about the forty-fifth year—the greatest age investigated. Figure 16 shows the shape of the curve.

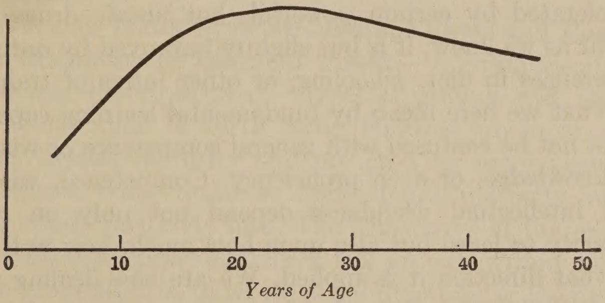

Fig. 16.—Growth Curve of Learning Capacity. Ability to learn increases up to beyond the twentieth year and soon begins to decline slowly. (From E. L. Thorndike, *Adult Learning*. The Macmillan Company.)

A variety of studies indicates that the development of the fundamental functions of the neurones, modifiability and retentiveness, is due to maturation in substantially the same sense that the growth of height, or speed of motor response is and, as in the case of the latter traits, growth of these neural functions will not go on at all without the coöperation of environmental factors. But given an average environment—food, rest, activity, incentives—growth goes on at a rather uniform rate and persists until a maximum is reached. The rate and developmental limit differ among individuals when environmental factors are substantially the same in potency and yet, for any one individual the rate and limit are but little affected by any save extraordinary variations in environment. The growth may be retarded by accidents, disease and extraordinary circumstances and perhaps accelerated by certain powerful, but unsafe drugs, but as far as we know, it is but slightly improved by ordinary differences in diet, schooling, or other forms of training.

What we here mean by fundamental learning capacity must not be confused with general competence or wisdom or knowledge, or even proficiency. Competence, wisdom and intellectual usefulness depend not only on one's capacity to learn but also upon how much, how well and in what direction it is applied. We are now dealing with the underlying, constitutional capacity and not with the results of its application, which will concern us in later chapters.

GENERAL CHARACTERISTICS OF GROWTH

Now that curves of growth and certain particular facts about growth of several structures and functions have been observed, we may survey briefly some of the general characteristics of development. This survey will be in part a summary of facts previously presented and in part a presentation of new facts which appear when those already mentioned are viewed in relation to each other.

1. Growth from Inception to Maturity Is Continuous Rather than Periodic or Spasmodic.—A review of the various curves of growth of structures and functions presented in this chapter will show that development is gradual and uniform rather than jerky and intermittent. Height, weight, speed of reactions, sexual functions, capacities to learn, increase steadily and not by leaps and bounds. Exceptions may occur. Indeed, exceptions may be produced by violent changes in extrinsic factors, such as starvation or excessive feeding, extreme exertion or inactivity, drugs, diseases, accidents. Continuous rather than periodic or spasmodic growth is nevertheless the general rule.

2. Various Traits Grow at Different Rates and Reach Their Maximum at Different Times.—A comparison of the several descriptions of curves of growth will show that at the time of birth some features are more advanced toward maturity and are growing more rapidly than others. Some reach an approximate maturity very early; others relatively late. The sensitivity of the sense organs attains approximately a full growth within three to five years after birth whereas the functions of the nervous system presumed to underlie the capacity to learn probably do not reach a maximum until the age of twenty-two. Other traits mature at various times between these extremes.

3. Individuals Differ in the Rate of Growth and the Mature Levels Attained.—In all types of growth that have been measured it is found that wide individual differences exist in the rate of growth. This fact is shown in the various individual curves for height (Figure 13). In these curves it may be noted that individual differences appear at any early age; they are present in fact at birth. At any given age, the taller ones have necessarily grown faster than the shorter ones. Similar variations appear at each consecutive year until maturity and thereafter. The absolute differences among individuals also become greater until at maturity they reach a maximum. Thus in Figure 13 the difference between girls 1 and 4 at 16 years is about 2.3 inches whereas at 8 years it is only 2 inches. The *relative* differences between the various individuals tend however to be approximately the same at all ages. Thus girl 1 exceeds girl 4 by about 4 per cent all along the line. Curves of growth for other traits reveal substantially the same facts.

4. Each Individual's Growth in a Particular Trait Tends to Maintain a Constant Relation to the Growth of Other Individuals in the Same Trait.—This statement means not only that growth tends to be continuous but that the curves for different individuals in a given trait tend to have the same general form. The curves in Figures 13 and 14 will illustrate this principle. Thus the individual who is tallest early tends to maintain his position all along. The person who is growing most slowly, or at an average rate in his early years tends to grow at a similar rate until maturity. Although there are exceptions to this rule, it holds in general and for nearly all traits regardless of whether the typical growth-curve is convex, straight, or concave.

5. A Given Individual, in Comparison with Other Individuals, Does Not Grow Equally Rapidly in All Respects.—The facts indicated by this heading are really extremely complex and are not fully indicated by the brief statement. The main fact is that growth is considerably specialized. A child, in comparison with other children, does not show equally rapid, average or slow growth in *every* trait. If his growth in stature is average, his growth in capacity to learn may be more or less rapid or about the same. Growth of various traits in a given individual may vary considerably from the average. The various types of growth are not *entirely* independent, however. There is a general tendency, but only a tendency, for an individual who grows rapidly (or at an average or slow rate) in one trait to grow at a similar pace in other traits. These tendencies toward correlation or correspondence are unfortunately very complex and varied. Although there are various degrees of correspondence ranging from extremely slight to very considerable degrees, the general tendency is so moderate that we may safely suggest a practical conclusion. It is that growth, all things considered, is so specialized that the development of each trait must be independently studied and evaluated.

6. Irregularities in the Growth of a Particular Trait in a Particular Individual Are More Likely to Be Caused by Environmental than by Hereditary Factors.—To understand this principle, it is necessary to distinguish between a variation shown in a general curve made by combining the curves for many individuals and a curve for a single individual. A variation from a symmetrical curve shown by all, or nearly all, persons is probably due to innate influences. The typical curve of growth in height made by combining records for a large number of boys shows a slight acceleration between thirteen and sixteen—an "adolescent spurt" it is sometimes called. This variation is a feature of the general curve. By an *irregularity* we mean a variation peculiar to a particular individual and not typical of the general curve. Such individual variations may be seen in some of the curves in Figure 13. Irregularities of these types are more likely to be due to extrinsic factors, such as improper food, inadequate sunshine, poison from diseased tonsils, infections in a gland, or to mental disturbances which may indirectly result in nutritive disturbances and so on. For this reason a parent or teacher should not assume that the arrest of any form of growth in height, weight, capacity to learn, or other trait is a necessary feature which will "pass off" with time. She should, on the contrary, search for an explanation among environmental factors.

7. Growth Is Due Both to Heredity and Environmental Factors.—It should be recalled that whatever the shape of a curve of growth, development is due jointly to heredity and environmental factors. Growth is not due wholly to the unfolding of innate powers nor is it wholly the result of the pressure of external forces upon an impotent substance. It is the result of an interaction of two factors. A flower seed will not grow without soil; but soil will not make a grain of sand grow into a flower. The growth of a plant or human germ requires continuous stimulus and sustenance from the environment. The final product in both cases will vary both with the original character and the subsequent cultivation of the seed. *Heredity determines the direction and sets the limits of growth; environment must sustain and may, in various degrees, modify growth.*

8. Exceptional Environmental Factors Influence the Growth of Some Traits More than Others.—Finally, it should be recalled that, although no growth occurs without environmental stimulus and sustenance, and although most traits tend to follow a fairly predictable course when the environment is typical or average, some traits, in their growth, are distinctly more subject to exceptional extrinsic factors than others. Weight is more easily varied by changing conditions of life than is height; spelling ability is more subject to change than speed of speech. Some functions are as difficult to modify as some structures. It is impossible unfortunately to make any statement about the degree to which human traits in general may be modified by unusually favorable or unfavorable accidents, incentives, diet, education or experience. Each structure and function must be investigated by itself. As students of education, we are primarily interested in functions, especially mental functions, and in discovering in what manner and to what extent special opportunities and guidance, motivation and instruction will improve them. Much of this book will be devoted to this general problem.

Conclusions concerning Methods of Predicting Human Growth

Now that our survey of several rather complex fields of investigation has been completed, we should raise again the practical question of how best to predict what a child is going to be. If the child we are interested in is not yet born, we will have to base our prophecy on the characteristics of the child's ancestors. The more accurately we can measure the traits of the ancestors, the better the prediction should be. We should give greatest weight to the characteristics of the parents, but we should also secure as much information as we can about the child's more remote ancestors since he will resemble them as well as his immediate forbears. But, even with all the characteristics of his forbears from parents to great-great-grandparents at hand, our forecast will lack satisfactory definiteness because it can be made only in terms of general probability.

If the child is already born, the thing to do is to measure him, for the characteristics of interest, at once. A prediction based on this single measure, in the case of many traits, is likely to be more accurate than one based on all the information one can gather about the child's ancestors. Better still, repeat the measurements at intervals over a period of several years until the slope of a growth-curve of the trait can be determined. From such segments of curves obtained even in infancy, forecasts of the future of the curve can be made with accuracy sufficient to be highly useful in practical work.

QUESTIONS AND EXERCISES

1. Discuss this statement: "It is impossible that she could be a bright child since both her parents were dull."

2. Discuss this statement: "Mary must really have inherited much less than Jane since Jane resembles her parents much more than Mary does."

3. Give several explanations of the fact that a son of average or lower capacity *might* be born to a man (or woman) of markedly superior capacity. Is it very probable, however?

4. Discuss the statements that individual differences, in one sense, become greater among children as they grow older whereas, in another sense, they remain about the same.

5. Is it possible for a person to resemble his grandfather more than his father? Which will he most frequently resemble the more?

6. Select a half dozen of the most eminent men or women in your community and find out what you can about their ancestors. Do the facts suggest "regression" toward the average? If they do not, how could you explain them?

7. Mary Doe's mother and father are about equal in intelligence to Jane Roe's parents but Mary Doe's grandparents for several generations were also highly intelligent whereas Jane Roe's were not. Who is more likely to be of higher intelligence, Mary or Jane? Explain.

8. Suggest practical values that could result from ability to predict, when a child is five years old, what his status would be at maturity in each of the following traits: a. Height, weight and strength; b. Resistance to tuberculosis; c. Capacity for scholastic achievement; d. Speed and facility of manual activity; e. Musical aptitude.

9. Give some illustrations of specialization in growth among your acquaintances.

10. Did the text say that a person who grows rapidly in one trait must compensate for it by growing slowly in some other trait?

11. Comment on the following assertions: a. "I am sure that my son's good nature is due to the fact that for months before he was born I kept myself in the most cheerful frame of mind"; b. "Before John was born, I was terribly frightened by a dog that barked at me unexpectedly. This fact accounts for John's fear of a barking dog";

c. "I wanted so much to have a child who would love beauty. I am sure Fred will love beauty because for months before he was born I devoted most of my time to appreciating fine music, art, nature and literature."

12. Comment on this statement: "Any boy can be a tall or bright or talented man if he wants to. It is merely a matter of trying hard enough and long enough."

13. Mention the statements made in the text concerning the validity of which you have the most serious doubt. Give your reasons for doubt.

14. Name the facts or principles mentioned in the chapter that have the greatest importance for education.

15. What difference does it make whether growth of any trait is primarily determined by intrinsic or extrinsic factors?

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CHAPTER IV

DEVELOPMENT OF BEHAVIOR

In the preceding chapter we studied at some length the growth of certain bodily organs and of certain functions and capacities. We found that various structures are well along the road of development at the time of birth. We found also that several functions such as sensitivity of the sense organs were well advanced at birth. Both structures and functions continue to grow after birth. Some of them proceed continuously and rapidly to an early maximum; others steadily but more slowly to a later maturity. Many of the structures and elementary functions seem to pursue their course chiefly as the result of inner growth or maturation, although in every case environmental stimulus and sustenance are required, and all organs and capacities can be modified, in their growth, by extreme variations in the environment.

If we observe the development of human infants, we shall find, in addition to physical structures and capacities, and depending upon them a wide variety of activities,—crying, breathing, grasping, creeping, walking, struggling,—going on immediately after birth or appearing at a later time. The question now arises as to whether all of these activities are acquired as the result of experience and learning or whether some of these reactions are, like the growth of bones or the appearance of teeth, the result of a process of maturation.

Behavior Results from the Joint Influences of Maturation and Learning.—At the outset of our inquiry it may be said that forms of behavior—that is, reactions of the organism to stimuli—are made possible as the combined result of learning and maturation. Learning and maturation are important concepts for students of education. Every particular response is due partly to each of these two influences. Some forms of behavior are due to a larger proportion of one; others to a larger proportion of the other. It is of importance therefore to determine what reactions are due chiefly to sheer maturation and what ones are mainly the result of learning. Such information is important because it will enable us to apply education to the greatest advantage. If walking, for example, is an activity that is really not learned but primarily an expression of a stage of maturation, it will be largely a waste of time to introduce an early and intensive program of teaching a child to walk. It will be better to await upon maturation and to let growth largely take its course. On the other hand, if writing is an ability that does not appear as the result of mere growth but requires on the contrary careful and extensive education on the part of the teacher and learning on the part of the child, we should know that such is the case so that we can set about to find the best time and method to introduce instruction. For these reasons we must consider the influences of maturation and learning upon a number of important activities. We shall devote this chapter to the general problem and give special attention to the factor of maturation. Later we shall devote many chapters primarily to the matter of learning.

TWO TYPES OF MATURATION: MATURATION OF STRUCTURES IN THE GROSS AND MATURATION OF SPECIFIC NEURAL CONNECTIONS

The drift of psychological theory requires that we begin our discussion by differentiating between two types of maturation. One type includes those forms of maturation discussed in the preceding chapter. This type includes the growth of muscles, bones, glands, the nervous system and other bodily organs in a general way. It refers to the fact that most organs tend, as a result of maturation, to become bigger, stronger, more efficient—in general, better organs. This form of maturation, as we observed in the preceding chapter, carries with it the growth of elementary functions or capacities. For example, as muscles and bones mature they become not only bigger, but also stronger, more responsive, more rapid and smooth-working mechanisms. Growth in these respects makes possible more efficient reaction. For example, if education and all other factors were equal in the case of two twelve-months-old infants, the one with tougher bones and stronger and quicker muscles would doubtless move, crawl, walk, manipulate objects and do other things better than the one with less mature structures. A particular infant may be able to walk chiefly because he is big, rigid and strong enough to do so whereas another cannot walk merely because he is still too little and weak. At any rate it is quite certain that walking, and many other activities, cannot be carried out until a child's organism has reached a certain stage of maturity.

General maturation of the organism is an important basis for any form of response. The question to be discussed primarily in this chapter is whether general maturation of the organism is the *only* important maturation factor.

The Theory of Instinctive Activity.—According to a very old and, until recently, a much respected theory, mere growth of the organism, even general maturation plus learning, is not enough to explain the development of certain kinds of reactions. It is asserted that there is a second kind of maturation, namely, a kind of intrinsic growth of synaptic connections in the central nervous system which makes possible a number of complex, coördinated reactions. It is argued that the growth of the nervous system is something more than mere *general* increase in modifiability and retentiveness—characteristics which were spoken of in the preceding chapter as comprising capacities of the nervous system. It is believed that various *complex patterns* of neural connections appear as the result of sheer growth and that many complex, coördinated responses appear only when these neural patterns have matured sufficiently to function. Thus it might be argued that sucking and swallowing food, crawling, making vocal sounds, walking and other complex reactions appear only when certain patterns of synaptic connections in the nervous system have reached a minimum essential stage of maturity. These patterns in the nervous system result in directing nerve impulses into the proper organs at a proper time and in proper order to produce the sucking, walking or other reactions. While the organs of response must also be mature enough to react when the nerve impulses reach them, mere strength of the organs is not enough. The specific neural connections are also absolutely essential. And while practice or learning may facilitate the development of ability to walk, it does not alone produce the necessary neural connections. The inner growth of neural connections is also, and primarily, responsible for the response. This at least has been the contention of a group of eminent biologists and psychologists.

The hypothesis that many forms of complex behavior can and do appear primarily, or in some measure, as the result of inner maturation of neural connections is known as the *Theory of Instinctive Activity*. Reactions found to be due primarily to such growth, which in turn is due presumably to predisposing factors existing in the germ cells, have been called *Instincts*. Since few, if any, instances are found in which specific neural growth is the *only* thing essential to behavior, (without any influence of general maturation of the organism or of learning) the tendency recently has been to drop the rigid noun, instinct, and to say that in such and such a degree a particular reaction is *instinctive, native, inherited,* or *unlearned.*

Two Types of Learning.—Before making a critical study of the *Theory of Instinctive Activities*, we should say a few words about learning. For convenience, we may speak of two kinds of learning. One is *direct or specific learning* and the other is *indirect or transferred learning.* You can gain in ability to do an act by going straight at it, by practicing the act directly, or by going at it indirectly and profiting from what is called the transfer of training. For example, if your purpose is to improve your fingering of the piano keys, you will probably practice specifically the activities of fingering the piano keys. That would be direct learning; direct application to the specific task. But, if you should be practicing the act of running a typewriter, you might be indirectly improving your ability to strike the piano keys. In striking the typewriter keys, you might acquire certain types of finger reactions that would transfer to and work upon the piano keys. This would be indirect learning; ability acquired in one situation would transfer to another more or less different situation. Consequently when we are discussing the question whether a child becomes able to walk because of general maturation of the organism or because of maturation of specific neural connections or because of learning, we must consider the extent to which that child has had *indirect* training which might result in a transfer of ability to walking as well as whether he has had any *direct* practice in the specific business of walking. As you may readily anticipate both types of learning usually contribute something to each complex reaction of the organism. The question now to be raised is how much learning contributes in comparison with the two forms of maturation.

Theoretical Basis of the Instinct Theory

The theoretical arguments in favor of the instinct theory are two; one resting on an analogy between the growth of bodily organs and capacities and the growth of behavior, the other on an analogy between animal and human behavior.

Analogy with Growth of Organs and Functions.—The first theoretical consideration is based on the assumption that the growth of neural connections, upon which instinctive behavior must depend, would most probably have the same general character as the growth of bones, skin, sensory and other organs. If the eye color reaches its final form very shortly after birth, if the sensitivity of the sense organs reaches a limit several years later as the result of maturation, then, it is argued, it is reasonable to admit the possibility that types of behavior such as forms of manipulation and vocalization, abilities to manage the body as in locomotion, etc., may develop gradually and mature at some time after birth mainly as the result of maturation of connections in the nervous system. Again, it is argued that as the growth of the permanent teeth or of hair on the boy's lip begins, or at least develops in a spurt, considerably after birth, so the appearance of certain forms of behavior such as walking, fighting or courting may be delayed flowering of neural growth. Birth, it is pointed out, is not a period of metamorphosis but merely an incident in development; growth may continue thereafter quite as before. Maturation of neural connections is no less possible, theoretically, than maturation of muscles, teeth, bones or glands.

Analogy with Animal Behavior.—In addition to the argument based on analogy with the growth and delayed appearance of bodily structure, the theory seeks support in the conviction that complex reactions appear instinctively in animals and are therefore probably found in man. It is first assumed that many of the activities such as web spinning, nest building, flying, mating and stalking prey, of insects, fish, birds and beasts are instinctive. If this assumption is correct, then it is reasonable to suppose, in the light of the theory of evolution, that analogous activities in man are also instinctive. Indeed, many believe that man, the most complex of living organisms, should possess an instinctive equipment more extensive and complex than that of any other organism.

Evidence of Instinctive Activities in Animals

Before the argument that man possesses instinctive reactions similar in extent to those of animals can be given weight, it is necessary to demonstrate the existence of such instincts in the animals. Evidence may be sought both in the results of observations and controlled experiments. We shall offer the results of but one of these investigations.

Study of the Flying of Birds.—Some newly hatched birds were taken (by Spalding) and each locked up in a box so small that it was unable even to stretch its wings and isolated so that it could not observe other birds in flight. Thus these birds were deprived of all opportunity to learn until others, hatched at the same time, had become competent performers. Then the caged birds were released. They were able to fly at once, almost but not quite as well as the birds which had not been imprisoned. Their control was not quite as good; alighting for a time was clumsy, but a large part of the ability to fly had developed without direct or any obvious indirect practice.

Since the acts of flying included taking off, controlling the wings, legs, head and neck, keeping right side up, avoiding obstacles, curving down and up and complex variations of the movements of all of these organs in alighting, it is fair to describe such a performance as a complex coördinated series of responses. Since they are apparently not the result of specific practice in flying and rather difficult to account for entirely as due to general maturity, although it doubtless plays an important part, the theory of instinctive reactions seems valid in at least one instance among animals. Other examples have also been yielded by experiment.

Other Evidence from Observation.—Numerous observations of moths, wasps, bees and other insects make highly probable the existence of complex instincts in these organisms. The early or rapid appearance of walking, running, scratching, swimming, huddling, ruffling feathers when cold, stretching feathers to avoid sunlight and the even more complex acts of stalking prey, gathering and hoarding food, of fighting, running away, hiding, shamming death in several species suggests strongly that many of such abilities are instinctive. The highly complex activities of courtship and mating, of building nests or other habitations, of hatching eggs and caring for the young, are believed to be in many species so complex, so universal and invariable, and so prompt to appear at the proper time as to make maturation a far more likely explanation than learning. The belief that many forms of animal behavior are instinctive is supported also by the fact that animal infants are able to manage themselves much earlier than human infants are. The human infant is notably helpless at birth and slow in becoming able to talk, walk and take care of himself. If we do not attribute the animal's rapid development to maturation we must attribute it to superiority in ability to learn. The assumption that animal infants surpass the human baby in capacity to learn is a highly improbable one.

ARGUMENTS CONCERNING INSTINCTIVE ACTIVITIES IN MAN

Some students—as was mentioned earlier—are disposed to think of the human species as resembling the lower animals with respect to native equipment. Finding evidence that complex patterns of response are inherited by animals they are convinced that in man many complex acts are also native.

To this view there are other competent students who object. They object, first, to the argument that man has all of these varieties of instinctive equipment because they appear in animals. They need not deny the theory of evolution but may merely assert that if the human species developed from lower mammalian forms, native equipment may have run less extensively to specific instinctive activities and more to intelligence and the capacity to learn. Man, they maintain, differs from the lower animals by possessing greater aptitude for learning, for profiting by experience and a relatively long period of infancy in which to acquire adaptations to his surroundings. He differs from the lower organisms, secondly, by possessing fewer ready-made adjustments, fewer specific instincts. More than other animals, it is urged, man is left to mold his behavior according to the situations and needs encountered; more than other organisms he is freed from the blind impulses of inherited specific reactions.

It must be admitted that these are reasonable objections. It would be very risky to assume that many reactions appearing in the early life of human beings appear without learning merely because complex acts are instinctive in animals. The experiments on animals are at least suggestive and they will be more so if similar studies on human beings yield similar results. Let us turn then to the few studies of human subjects.

Studies of Human Instinctive Activities

Human Clasping Reactions Made Soon after Birth.—The first line of evidence favoring the theory that complex, coördinated forms of behavior appear as the result of maturation without training, education, or opportunity to practice or otherwise to *learn* to do the act, comes from many observations of infants immediately or soon after their birth. For example, an infant shortly after birth will clasp a small rod placed against its palm with such effectiveness and tenacity that it can be lifted clear of support. Many infants can maintain their whole weight by this clasp of a stick for some time. Since this form of reaction appears so early, so universally and so definitely, it would seem to be instinctive.

It is possible, however, that this vigorous reaction may be explained as due merely to maturation, prior to birth, of the structures and elementary functions involved. At any rate, the clasping response could not occur had not the muscles, bones and nerves and their functional capacities attained a certain degree of maturity, by the time of birth. It is possible, then, that the clasping reaction requires no other explanation than maturation of structures and functions such as were discussed in the preceding chapter and not the maturation of a specific pattern of neural connections in the nervous system. But let us view some further responses of the newborn child.

Sucking, Swallowing, Digestive and Other Activities Appearing Soon after Birth.—Some infants greet the external world with a sneeze; others with a cry of annoyance. All normal infants have at birth a heart that will beat, lungs that will breathe, mouths that will open and close, make sounds, spit out and suck, throats that will swallow, stomachs that will churn and digest. Newborn infants are capable of very complex patterns and series of reactions which regulate the bodily temperature. The food-managing reactions involve a series of complicated acts resulting in sucking, moving fluid to the back of the mouth, swallowing, digesting, assimilating and excreting. Here we find not only complex action, but highly coördinated action. Certain organs, like the mouth parts, moreover, react complexly now as part of one act, as in crying, now as part of another as in sucking and swallowing. Organs in various parts of the body coöperate immediately after birth in joint activities that are so complicated that to attempt to explain them as due to mere general maturation of isolated structures seems inadequate. Certainly, many of these early activities, especially those of great value in survival, suggest that complex patterns of neural connections have developed apart from a process of learning or practice. Since no environmental factors or training could reasonably be assumed to impress these patterns of connections upon the nervous system before birth, it seems sensible to assume that predispositions toward such specialized neural growth were inherent in the germs cells. Since the infant was not trained and could not learn before birth how to make such reactions and since reactions of equally complex character, such as learning to write or wiggle the ears later in life require a long period of learning, it seems only reasonable to conclude that many of the reactions appearing soon after birth are instinctive or unlearned.

Are Reactions Appearing Later Ever Unlearned?—If a complex reaction can result from mere maturation of the neural connections and the organs, muscles, bones, etc., involved, before birth, could not other complicated acts appear at any later time without practice or learning? Theoretically, it would seem possible. Yet, we must demand good, scientific evidence before asserting that such is the case. We should like to see the results of studies upon human infants like those performed on the flying of birds.

Only a few such studies have been performed as yet. A very significant one, very similar to the study of flying in birds, but not so conclusive in its results, will be described.

The Influence of Growth and Learning upon Climbing.—In this experiment (performed by Gesell and Thompson) two identical twins correspond to the brood of infant birds. The investigators, by using several hundred tests, selected a pair who were substantially identical in all important respects. At the beginning of the experiment each was practically a duplicate of the other. When they reached the age of 46 weeks, one twin, *T*, was given a test in climbing up a stair which led from the floor to the edge of a high crib on which an attractive object was exposed. *T* at this age reached the top slowly and clumsily and not without some assistance. The other twin, *U*, who was not given the test, would certainly have shown substantially the same performance at this time. *U's* first trial was postponed until later. *U* was not permitted to practice climbing, to see anyone else climbing or otherwise to get any *direct* experience in climbing until she was 53 weeks old. Then *U* was given her first trial. Whereas *T*, at 46 weeks of age, was slow and clumsy and unable to make the top alone, her twin, *U*, at 53 weeks mounted the stairs without assistance in 45 seconds, a rather good record. Since the evidence is that *T* and *U* were, at the age of 46 weeks substantially identical persons, and since *U* had had no experience with stairs from that time until she was 53 weeks old, it seems proper to assume that the greater ability of *U* on her first trial was the result of growth which went on without practice in the specific act of climbing.

Whether this growth which went on without practice, in the case of *U*, is to be explained as mere general maturing of muscles, bones and nervous system—to mere general increase in strength and agility—or to development of a specific pattern of neural connections or to both, is not easy to discover. We cannot be sure either that the ability to climb was not in a considerable measure due to transfer from crawling, pulling oneself upon boxes, attempting to climb over obstacles on the floor, etc. Unlike the birds, these infants were not penned up where they were unable to exercise the body parts used in the test.

Other Investigations of Delayed Reactions.—These investigators conducted a study of reactions to small toy blocks upon the same twins, which revealed the same general fact. Instances have been reported of children whose first attempts at walking have been held up beyond the usual time. When these infants were then given their first trial, they were able to walk very much better than comparable infants, who made their first attempts earlier. In several cases on record, then, evidence is to be found favoring the theory that certain complex activities of high biological value can be performed with rather marked ability without previous education, practice, or learning of *those particular reactions* or even of others closely enough related to make the possibility of transfer a satisfactory explanation. The appearance of a few complex reactions, then, may be attributed to maturation of structures including neural connections as contrasted with changes due to specific learning or transferred learning.

Maturation and Learning Usually Go On Together.—These experiments upon animal and human infants result, of course, in an artificial type of life for the individuals who are not permitted to attempt an activity until later than usual. The normal thing is for an infant to try to talk, walk, or climb before his mechanisms are capable of doing the act perfectly. He usually starts when he is rather clumsy and incompetent in the activity. Thus he learns and matures at the same time. Since normally, growth and training go hand in hand, it is very difficult to determine just how much either contributes or when and how much education and practice should be introduced in the case of such fundamental activities as walking, talking, manipulating and the like.

A Study of the Relative Influence of Maturation and Learning.—Fortunately, Gesell and Thompson conducted their study of the twins *T* and *U* in such a way as to give an idea of the relative influences of growth and specific training in the case of stair-climbing. Twin *T*, in her 46th week began to receive daily education and training in climbing. This learning was continued for six weeks. Then *U* was given her first trial. Now, while *U*'s first trial was much better than *T*'s first attempt six weeks before, it was not quite as good as *T*'s present performance, when both were in their 53rd week. Since *T* and *U* were of the same age and otherwise equal except that *T* had had six weeks of training in climbing whereas *U* had had none, the difference between the two records represents the results of the six weeks of learning. The learning process, then, makes itself felt. It resulted in making *T* a somewhat more polished and rapid climber but not an infinitely better climber.

Gesell and Thompson pushed the study of these influences still further. Twin *U*, who had been allowed no training while *T* was having a daily session for the six weeks preceding the 53rd week, was now given daily training while *T* received none. *U* learned very rapidly. Indeed, in less than *two weeks* *U* surpassed the record established by *T* at the end of her *six weeks* of practice. Upon completing her full two weeks of practice, *U*, at the age of 55 weeks, climbed the stairs in 10 seconds, which was better than *T*'s record of 25 seconds made at the age of 52 weeks after six weeks of practice or three times as much. Thus *U*'s advantage of two weeks in *maturity* more than outweighed *T*'s advantage of four weeks of *training*. Thus, it appears that in the case of climbing, maturation brings about the same kind of improvement in ability that education does. Early and intensive training does not produce such an ability from zero; it merely hastens and polishes off a gradually growing reaction pattern. Education, moreover, if introduced too early and applied too generously, may be largely wasted, as further observations of *T* and *U* indicate.

When *T* and *U* reached the same age of 56 weeks, although *T* had been trained 6 weeks (from the 46th to the 52d week, inclusive) and *U* had been trained only 2 weeks (the 54th and 55th weeks), both were of equal ability. At the age of 79 weeks although both were better climbers than at the 56th week, they were still equal. Although *T*'s early and more intensive training, therefore, had appreciable effect, the advantage was largely immediate and temporary. Here again, equal constitutional factors underlying climbing seemed to outweigh the influence of unequal experience.

Now, we must be careful how we interpret these results. The experiment, first of all, does not prove that a child can climb well without training or learning or that practice has *no* effect. Neither child was very expert on his first trial. Both improved rapidly with experience. Both became better climbers by practice in climbing. On the other hand, the experiment does prove that climbing depends to a great extent upon maturation apart from practice. It shows also that the effect of native constitution upon ability to acquire such forms of behavior is great. It suggests that only by having a very great and long-persisting educational advantage could one child continuously excel another of equal native aptitude. It suggests, furthermore, that to have the greatest and most economical effects, education should be adjusted nicely to the stage of maturation. Thus much of the early training devoted to *T* was wasted so far as its permanent effect is concerned. *U*'s training, although only a third as great, was of equal permanent value because it came, apparently, at a more opportune time and was not continued long after a sort of "physiological limit" had been reached. Thus in many ways to be explained more fully later, the process of education is bound up with the process of maturation; nurture and nature must both be considered in educational work.

Behavior Jointly Determined by Growth and Learning.—The main generalization which we wish to make at this time is merely that such an experiment indicates that some forms of behavior, as well as structures and functions, are subject to maturation and to native limitations. Behavior cannot be thought of as something entirely explicable in terms of amount and kind of opportunity, practice, education or other extrinsic factors. The intrinsic factors independent of learning were far more potent than the influence of opportunity and tuition under the circumstances of the study just reported. In a similar study of skill in manipulating small playing blocks (by the same authors) and in an investigation of a mental reaction over a much longer period (by Gates and Taylor) the influence of intensive specific training was found to be still less. In many other studies, on the other hand, it had been found that special advantages in such functions as handwriting, typewriting, reading, etc., may produce results vastly superior to those obtained by less extensive or less sagacious or less well-timed practice. The relative influence of intrinsic and extrinsic factors varies greatly among different reaction patterns quite as it does among different structures and functions, as we observed in the preceding chapter.

Summary.—In summary, it may be said that the appearance and growth of any form of behavior may be due, in some measure, to each of the following four factors:

(1) Maturation of the organism, of its muscles, bones, glands, nervous system, etc., in general—to getting generally bigger and better.
(2) Maturation of specific connections in the nervous system. Some reactions are, in other words, in some measure instinctive.
(3) Learning by direct practice in the specific activity or response in question.
(4) Learning by the indirect method of utilizing abilities transferred from other situations in which they were acquired.

A SURVEY OF THE INSTINCTIVE REACTIONS OF INFANTS

Since the influence of maturation and learning vary greatly from activity to activity, even in infancy, it will be advisable to attempt to suggest what types of motor reactions are most likely to appear with relatively little special training. Such an inventory cannot be made with any degree of certainty until more experiments like those on climbing have been done. The following survey is based largely on observations of infants made by several persons (especially Shinn, Preyer, Thorndike, Gesell, Bühler and Watson).

Various important reactions which put in an early appearance may be conveniently grouped under the following headings:

(1) Adjustments of the sense organs.
(2) Seeking and accepting reactions.
(3) Protective reactions.
(4) Locomotion.
(5) Vocalization.
(6) Manipulation.
(7) Mental activities.

1. Adjustments of the Sense Organs.—Observations of infants during the first day of life indicate that all of the sense organs are functioning.

A gradual progress of sensory control and of ability to attend or to isolate for sensory observation is apparent however. For some time the infant fixates visually only very intense or mobile things. The definite visual fixation of the immobile human face or objects in the room appears clearly within a few weeks and later a disposition to explore actively with eyes, fingers and tongue. These abilities are clumsy and poorly coördinated at first. They result, it appears, from slow maturation combined with much practice. They correspond to the flowering of curiosity. Indeed, if we are not deceived by appearances, *the child early gives evidence of striving to comprehend the things and* *events about him.* He appears instinctively to be curious, to explore, to seek to learn.

2. Seeking and Accepting Reactions.—Since the adjustments of eye and ear to distant stimuli from the things about him—with the exception of a few very intense or striking events such as the moving light held near—appear some time after birth, the infant's earliest reactions are aroused mainly by stimuli from within the body such as pangs of hunger, or by forces which impinge upon the body's surface. What we may call seeking or accepting reactions are early observed. The *food-seeking and accepting reactions* including swallowing and digesting are prominent. Other forms of accepting reactions take a passive form—*quiescence, repose, submission, inactivity.* These are, however, to be considered as positive reactions. The struggling brought about by interfering with breathing or movement, by heat or cold, and by pain, internal or external, gives way to relaxation when the infant is turned, or the stimulus otherwise removed. *Sleep* is undoubtedly the extreme form of quiescence and relaxation; it is quite as instinctive, quite as much a reaction to stimuli as sucking or sneezing although the stimuli are undoubtedly complex, including both inner and outer conditions. During waking hours, varied acceptance reactions are made to conditions which embrace moderate warmth, internal comfort, filled stomach, etc., and a certain freedom for movement. The responses to these conditions are *repose or playful activities plus what may be described as contentment.* The child's reaction is that of acceptance which may be contrasted with rejecting and struggling, to be described later.

Reaching and grasping are native responses elicited early by a large number of objects—almost all small objects. Things grasped are carried to the mouth or later manipulated. Reaching and grasping are accepting responses. Gradually the infant learns which of the objects produce pain or discomfort and consequently soon fails to seize them; which are tasteful and henceforth carried to the mouth; which are noisy, mobile, etc., and henceforth are manipulated in various ways. Probably only the roughly coördinated acts of seizing, pulling toward the body, carrying to the mouth or variously manipulating are due primarily to maturation. The attachment of one of these forms of treatment, rather than others, to each particular object is acquired. All sorts of refinements and elaborations of the crude initial reactions depend upon practice.

3. Protective Reactions.—A considerable number of reactions elicited by stimuli which are often, if not always, harmful appear immediately or shortly after birth. *Such reactions take the forms of avoiding or escaping from, of pushing off or getting rid of the stimulus, of struggling, or of other protective responses such as closing the mouth or eyes.* These early-appearing reactions are often called *prepotent* since they take precedence over all others; they occur promptly at all times and may supplant other activities under way at the time. The biological utility of the prepotency of the protective responses is apparent.

To a number of physical contacts, the infant almost immediately after birth reacts by movements which usually result in escape from the stimulus. The foot or hand will be retracted from the application of a cold or hot stimulus, from a prick, tickle or pinch. If the stimulus is applied to parts not easily withdrawn, the infant will struggle until the body has been moved or the stimulus withdrawn. Probably maturation is responsible in a considerable measure for the simple types of escape reactions. As the child grows older, more complex reactions of escape, including turning about and flight, make their appearance, but as yet it is impossible to say to what extent these retreats are native. Doubtless the instinctive responses are rapidly and considerably modified by experience.

Struggling and Fighting.—When the head, arm, nose or other member of an infant is held in such a way that withdrawal from or removal of the restraining force is not promptly achieved, there soon begins a struggle which becomes more violent until the whole body is engaged. In such activities are forms both of repelling and escaping reactions; the infant struggles either to throw off the offending stimulus or to escape it. These activities constitute the earliest form of fighting. In later years, fighting continues to be a reaction to persistent interference with locomotion, eating, sleeping or other activities. Fighting takes on new details of form as the body develops; the native responses consist in the use in a violent and directed form, of all of the weapons—arms, fingers, legs, feet and possibly teeth—with which the species is equipped. Instinctive struggling and fighting are violent but nevertheless crude. In contests among individuals equal in strength, the trained boxer or wrestler is markedly superior. Even in such primitive activities, it is possible to improve vastly on native behavior.

4. Locomotion.—The mature forms of locomotion—walking and running—involve a number of complex activities that do not appear at the same time. Holding up and balancing the head appear early. Ability to turn the body about while lying down appears after several weeks. *Creeping*, the first form of locomotion, varies so much in character among different infants as to suggest a considerable influence of learning, although creeping includes many native reactions which are combined during practice. In *walking, running, climbing, balancing on a moving object* such as a wagon, etc., there is an unlearned core of action which is refined during learning. *Swimming is certainly not instinctive;* young infants show great fear and no useful activities when immersed in water.

5. Vocalization.—The native oral responses appear to be few and simple. Certain types of *crying and screaming* which are difficult to differentiate appear at birth in response to cold and various pains, hunger, being held tightly and other discomforts. *Cooings and gurgling* appear during pleasing experiences and probably a sort of *laughter* is native. In addition to these, a considerable number of single sounds appear in innumerable arrangements, none of which is very stable or characteristic. Out of these elementary oral responses, complex patterns are acquired as the result of practice. The human vocal apparatus, like those of other species, has its limitations; not every type of sound pattern can be imitated however great and prolonged the practice. The particular *patterns* of vocalization, except the earliest to appear in infancy, are mainly acquired. Yet, the patterns are made up of reactions which result largely from maturation.

6. Manipulation.—Aside from the manual reactions already described under seeking and accepting and under protective activities, the well formed native adjustments of a complex character are few. Like the vocal, nearly all of the manual abilities of the child of six or of the adult are learned. Learning consists largely in producing new combinations of unlearned and previously learned responses.

7. Mental Activities.—By "mental activities" we mean such activities as *perceiving* (seeing, hearing, smelling, tasting, touching an orange); *feeling* (pleasant, unpleasant, sad, timid); *thinking, imagining, reasoning, dream-*

ing, *recollecting*, *deciding* and so on. Are these activities native or acquired? All of these reactions represent our bodily mechanisms in action. Sense organs, reacting organs, and complicated neural apparatus are engaged in all of these mental activities. The machinery which makes mental activities possible is given us by nature. Indeed, these mental operations are merely the functional equivalents of the character and organization of our bodily organs. The *capacity* to perceive, to feel, to think or otherwise to react "mentally" is clearly a part of one's birthright. We are endowed with capacities for perceiving, feeling and thinking as we are for learning or acting with our muscles. This does not mean that we are endowed with unlearned images of things, or feelings about particular events or ideas of right and wrong. We are variously endowed with capacities to perceive facts, to feel about them and think with them, but the facts themselves result from experience. We do not inherit ready-formed ideas; we must acquire the information which we use in thinking.

CONCLUSIONS CONCERNING DEVELOPMENT OF BEHAVIOR

From the facts presented in this chapter thus far, certain general conclusions may be drawn. In the first place, whether we consider the results of special investigations such as those of climbing or the results of observations of infants' behavior, we find evidence for believing that the appearance and development of behavior depend upon four factors: (1) general maturation of the organism, (2) maturation of specific neural connections, (3) direct learning and (4) indirect learning. The significance of each of the factors merits some further discussion.

General Maturation of the Organism.—No form of reaction can appear before the muscles, bones, nervous system and other structures are sufficiently matured. It is futile to attempt to teach most children to walk before they are a year old because their structures are incapable of executing the act. This principle applies throughout the entire period of growth. It is wasteful to attempt to teach certain children to play and enjoy chess or to learn and enjoy geometry before their organisms have grown up to a certain level. A sufficient degree of maturity is one of the requirements for successful achievement in every kind of activity. For this reason studies of "readiness" for learning different activities such as writing, reading and others are being made in order to enable a teacher to tell accurately when she can most successfully introduce a pupil to learning different activities.

Maturation of Specific Neural Connections.—The appearance and development of certain forms of behavior seem to be due partly or largely to maturation of specific patterns of neural connections. Such activities are usually called instinctive reactions. In the experiments presented to indicate the validity of this assumption, certain extreme cases were described. These were cases, such as climbing, to which maturation makes a maximum contribution and learning a minimum. In our survey of the reactions of infants, we found it probable that relatively few of our everyday reactions are so largely based on maturation of neural connections. We found a number of reactions of a fundamental character, such as those grouped under (1) adjustments of the sense organs, (2) seeking and accepting reactions, (3) protective reactions, (4) locomotion, (5) vocalization, (6) manipulation, and (7) mental activities—which are probably in considerable measure instinctive. Those reactions which seemed most likely to be largely due to maturation—sucking, swallowing, protective and avoiding reactions, etc.—are of extreme value as means of survival. They are in a sense the basal materials out of which other reactions are later developed. More complex reactions appear both as refinements and as new combinations of these primary, instinctive ones. As we shall see in a later chapter, many of our fundamental interests and motives, the dynamic factors that initiate and sustain learning, find their origin in the reactions described under these seven headings.

Direct and Indirect Learning.—Despite the fact that several very fundamental reactions tend to appear largely as the result of maturation, learning looms as the big factor in the development of behavior. Maturation provides us in ready-to-use form only a few basal adjustments. Even many of these are modified considerably through learning, as when a child learns new tricks of eating, protecting himself and so on. We have to learn, moreover, what to eat, what to avoid, what to fear, what to perceive and think about. Compared to the full equipment of reactions possessed by an average adult, the instinctive adjustments are few, simple and mainly crude. All of the ideas and most of the skills which occupy our daily lives are largely the results of learning. Only a fraction, but nevertheless a very important fraction, of ordinary human skills are instinctive. The task left to learning in the modern world is colossal. We shall therefore find it necessary to devote several chapters to learning. In these chapters we shall inquire with more detail into the distinction between direct or specific learning on the one hand and indirect or transferred learning on the other.

Learning Conditioned by Native Limitations.—Our survey of maturation produced another conclusion, namely, that while most of our activities and skills are largely the outcome of learning rather than maturation, the rate and limits of maturation always markedly affect our proficiency in learning. Running a typewriter, operating a car and painting pictures are skills one must learn, but how quickly and well one can learn them depends upon the degree of development of one's structures and functions. Maturation then, not only produces the foundation and starting points of learning, but it also influences the direction, rate and limits of development which learning will bring about.

The survey of instinctive reactions, that is responses due to the specific maturation of connections in the nervous system, as distinguished from reactions resulting from connections acquired by practice or learning, indicates that there are a few cases in which the response is largely, if not wholly native, and a large number in which the connections are partly the result of maturation and partly the results of learning. On the whole, these reactions are so few and incomplete that the problem of teaching and learning is little diminished or simplified. On the contrary, the instinctive basis of behavior is such as to complicate, and increase the importance of education. The problem is complicated because the learning process, to be economical and fruitful, cannot be begun most profitably at any moment that strikes one's fancy nor pursued without regard to instinctive trends. "In all pedagogy," James aptly remarks, "the great thing is to strike the iron while hot." The importance of education, finally, is increased because behavior, on an instinctive, infantile level, so largely given over to a grasping, vegetative, offensive, defensive, resisting, fighting, "self-preservation," sort of life, presents strong dispositions that must be redirected before the habits essential to a better life can be established.

Need of Predictions of Developmental Status.—In several ways learning is conditioned by maturation. What to learn, when to learn and what one's success in learning is likely to be, are matters tied up with maturation of the organism and the appearance of instinctive tendencies as well as with the nature and kind of previous learning. In order to determine what each person should attempt to learn, when he should make the attempt and how successful he is likely to be we need to be able to predict the course of development of behavior. Only by knowing in plenty of time what a person's equipment will be, can we hope to adjust education economically and successfully to each stage in his development. Let us therefore turn to certain interesting efforts to plot schedules or curves of growth for behavior; curves which are similar in important respects to those for structures and functions observed in the preceding chapter.

Some Characteristics of Growth of Behavior

Studies of the Course of Growth of Reactions.—At the Yale Psycho-clinic under the direction of Arnold Gesell, consecutive tests of abilities to react to various situations have been made at intervals from the time of birth in such a way as to yield a chart or schedule of behavior that may be used like a height-growth curve. The chart in Figure 17 shows a "curve" of growth on which are indicated the reactions which appear in the average case, at intervals of a month from birth to the first birthday. This chart reproduces only part of a developmental schedule which extends from the first to the thirtieth month and includes a much larger number of activities.

Comparison of Growth of Behavior with Growth of Structures.—This growth schedule indicates the order and time in which reactions appear in the average child. Gesell finds that individuals, as they grow older, differ in the rate with which they proceed through this series. Some move from reaction to reaction more rapidly; others less rapidly than this average schedule. He finds, moreover, that in most cases, a child who progresses rapidly during the first few months continues to advance rapidly; the one who begins at an average rate, continues at a similar pace and the one who starts out slowly, continues slowly. There are exceptions to this rule that growth of behavior tends to continue at the pace at which it begins, just as there were in the case of physical traits. Striking

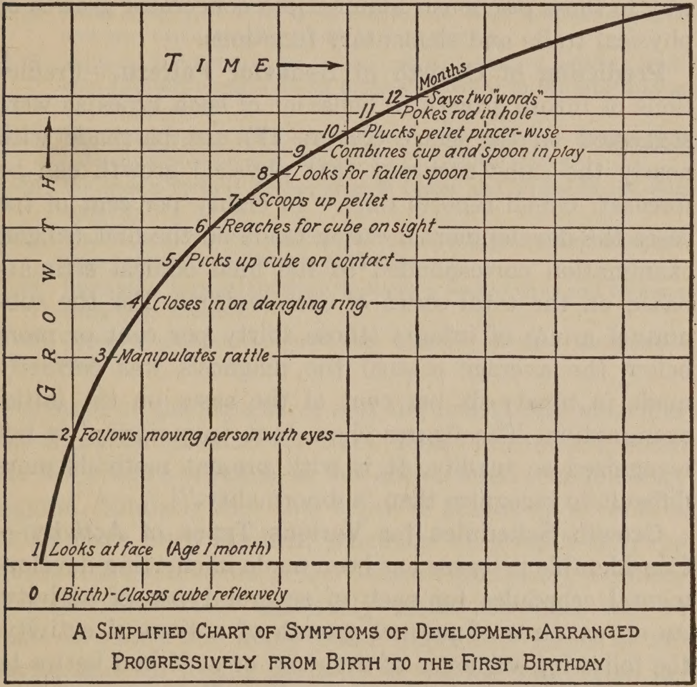

FIG. 17.—THIS CHART INDICATES ONE OF THE SEVERAL THINGS WHICH AN AVERAGE INFANT CAN DO AT THE END OF EACH MONTH. (From A. Gesell, *Infancy and Human Growth*, The Macmillan Company.)

exceptions, moreover, are usually found to be due to extreme extrinsic factors, such as variations in malnutrition and disease. But on the whole, the facts concerning growth of such forms of behavior conform in a striking way to those previously summarized concerning growth of physical traits and elementary functions.

Prediction of Growth of Behavior Pattern.—Predictions of future growth in behavior of such types as were suggested on the chart (Figure 17) can be made with nearly the same accuracy that physical growth can be forecast. Gesell reports that: "In eighty per cent of the cases the developmental rating made on the first (single) examination corresponded to the final clinical estimate based on the total series of examinations. For the subnormal group of infants (those thirty per cent or more below the average status) the diagnosis was correctly made in ninety-six per cent of the cases on the initial examination. The figures show that 'superiority' is not recognized so readily. It is with present methods more difficult to recognize than 'subnormality.'"

Growth Schedules for Various Types of Activity.—Considerable progress has been made in charting developmental schedules for each of several types of activity. As an example of normal growth of a type of activity, the following sequence of drawing, or as it had better be termed, crayon and paper behavior will serve.

BRIEF SUMMARY OF SEQUENCES IN CRAYON AND PAPER ACTIVITIES

(After Gesell)

MONTHS	
0–1	Clasps crayon without looking at it.
1–3	Clasps and manipulates crayon in increasingly complex ways without looking at it.
3–5	Begins to manipulate crayon and paper while looking at them. Clasps paper with both hands when presented favorably. Picks up crayon brought in contact with hand.

SUMMARY OF SEQUENCES IN CRAYON AND PAPER ACTIVITIES–*Continued*

MONTHS	
6 – 9	Reaches for crayon on sight. Brandishes, bangs and crumples. Puts crayon or paper in mouth but won't mark paper when examiner demonstrates.
9–12	Gives "fugitive" heed to demonstration. Gets crayon on paper and may make banging marks or faint scrawls.
12–18	Increase in attention to demonstration; imitative scribble; tendency to observe marks made; increased control in bringing crayon to bear on paper.
18–24	More and better scribbling. Makes crude imitative strokes and differentiates between a straight and a circular stroke.
24–30	Imitates a vertical stroke; attends better and longer to drawing activity.
30–36	Makes two or more strokes in attempting to imitate a square cross but rarely produces a good cross.
36-48	Imitates a horizontal stroke; imitates a square cross and copies a circle from a model.
48-60	Copies a cross and a square from a model; draws a recognizable man.

Growth of the structures and the neural and muscular coördinations essential for these achievements is gradual and not a series of jumps as this abbreviated schedule may suggest. Similarly for other types of activities, several of which have been studied, schedules of growth may be plotted for the first few years. It is certainly only a matter of time before these extremely useful schedules will be made available for many other important forms of behavior and for longer portions of the life span from infancy. From those now available certain important facts concerning the growth of reaction patterns may be derived.

Specialization in Growth.—Such reactions as appear in the crayon-paper activity schedule above tend to appear in that order in the case of different children, whether their growth is rapid, average or slow. In most other types of reaction—among those thus far studied—the particular abilities tend to appear in a typical order and at a rather constant pace. This does not mean, however, that a particular individual always, or even usually, grows at the same pace in every form of behavior, much less that he grows in behavior at the same pace which he shows in growth of bodily structures. Growth is not one and indivisible; it is quite specialized. One does not mature at the same rate in every respect; he tends to grow more rapidly in some than in others.

A given child may show more rapid growth in one form of behavior than in another, just as his height may grow more precociously than his visual sensitivity. The reality of such specialization is best shown, perhaps, by an extreme case, such as the following, reported by Gesell. The following table shows how far up the scale of average typical growth this child had gone in each of several traits:

	Level in Months	Average Level
Developmental Item		
Chronological age	56	56
Physical Traits		
Height	60	60
Weight	60	
Motor Control		
Body control	6	8.7
Locomotion	9	
Grasping	3	
Holding objects	12	
Vocalization	4	
Gesture (language)	18	
Physiological Reactions		
Bladder control	36	36
Bowel control	36	
Perceptional Reactions		
Number	36	48–55
Form and size	48–60	
Color	48–60	
Attention span	60	
Social insight	48–60	
Personal-Social Behavior		
Sociability	56–60	51–58
Play interests	36–48	
Emotional control	56–60	
Educational attitude	60	
Language comprehension	48–60	

Here is an extreme degree of specialization in growth. It shows, in general, very slow development of motor responses, moderate growth of physiological control, more rapid growth of perceptual reactions, still more rapid growth of certain social and educational abilities and a maximum growth in height and weight. Specialization in growth as pronounced as this is very unusual; but some degree of variation is normal. In practical work, therefore, while it is very useful to know what a person's average growth is—a fact suggested by averaging the scores for all types measured—it is also significant to observe the degree of variation among the several measures of growth and to attempt to account for the extremes. Only in this way can we adjust education and nurture to the exact needs of each individual.

Practical Uses of Behavior Charts and Standards of Comparison.—From the practical point of view, the most important outcome of this chapter is the fact that growth of behavior, in its biologically essential forms, tends to go on in an orderly, cumulative way. Due to this orderliness, it is possible to appraise a person's prospects for growth, even in his infancy. The ability to determine an individual's behavior-growth curves and to compare them with the average, enables us to diagnose more effectively the individual's needs and limitations. In one case, the needs for better diet, more sleep and medical treatment may be made apparent; in another, other kinds of incentives, opportunities, guidance and experience are desirable; in a third, cessation of premature educational pressure may be indicated. Early diagnosis, if it leads sagaciously to distinctions between the relative influence of innate and unmodifiable factors, on the one hand, and extrinsic and changeable influences on the other, makes possible prediction of future growth and therefore foresight of future needs and contingencies. The fact that growth of behavior is orderly and law-abiding is basal to all forms of educational guidance.

QUESTIONS AND EXERCISES

1. Consider the appearance and development of swimming. To what extent does each of the two forms of maturation and growth enter into them? Be specific. Do the same for side-stepping an object thrown at one.

2. What instinctive reactions, if any, does a boy of six make when first immersed in water? Of what value would a comprehensive answer to this question be to a swimming instructor?

3. Do you find any evidence in the chapter in favor of the theory that curiosity is instinctive? In what ways does continued growth and experience influence one's curiosity?

4. What are the four main sources of development in behavior? What are the relative influences of each of these factors in the following abilities:

   (a) The young infant's act of hammering with a spoon.
   (b) A two-year-old child's fear of the dark.
   (c) A five-year-old child's retreat from a strange dog.
   (d) An eight-year-old child's skill in catching a baseball.
   (e) An adolescent's worry about death.

5. If the reactions listed on pages 123 to 128 are the main inherited modes of response, what sorts of native *interests* or *urges* would you expect a five-year-old child to have?

6. Consider the instinctive reactions grouped under "accepting responses." Show how these elementary reactions may be elaborated into more complex behavior as the child grows up.

7. What activities of a six-year-old child probably have their roots in the "protective reactions" of infants listed in the chapter?

8. Is it assumed that men inherit ideas of right and wrong, of honesty, etc.?

9. What is meant by a "prepotent" reaction? What biological usefulness is suggested by the existence of certain prepotent instincts?

10. How would you determine whether climbing trees is native or acquired?

11. Discuss this opinion of John Dewey, "The native stock of instincts is practically the same everywhere. Exaggerate as much as we

like the native differences of Patagonians and Greeks, Sioux Indians and Hindoos, Bushmen and Chinese, their original differences will bear no comparison to the amount of difference found in custom and culture—the countless diversity of habits springs from practically the same capital stock of native instincts."

12. What reactions, if any, does an adult make which are nearly the same as those made in his infancy?

13. Criticize the conclusions which the author draws from the study of climbing by the two twins.

14. Review the general characteristics of growth given in the last section of Chapter III. Which of these characteristics are applicable to the growth of behavior?

15. Enumerate as many uses as you can to which the curves or schedules of growth of behavior may be put in education.

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Institute Publ. Co., 1925; and Ch. Bühler, *The First Year of Life*, John Day, 1930.

H. C. Lehman and P. A. Witty in *The Psychology of Play Activities*, Barnes, 1927, give some excellent data concerning the play activities of school children.

CHAPTER V

EMOTIONS

The discussion of instinctive responses, presented in the preceding chapter, was limited mainly to reactions of the striped muscles. It was concerned chiefly with the muscular reactions that result in grasping, manipulating, warding off objects and otherwise using the hands and arms; looking, listening and otherwise adjusting and using the sensory apparatus; crying, laughing and variously employing the organs of speech; walking, climbing, struggling and otherwise responding with the skeletal muscles of the whole body. Certain other forms of response were largely neglected, in particular the following:

(1) Reactions of the facial muscles, such as those producing the "expressions" of disgust, anger, or fear.
(2) Reactions of the smooth muscles which produce alterations in the activities of the stomach, intestines, arteries, etc.
(3) Reactions of the duct glands which produce the secretions sweat, tears, or gastric juice.
(4) Reactions of the endocrine glands which produce various internal secretions.

In this chapter we shall be concerned with the origin and growth, the characteristics and effects of certain reactions in which these organs are conspicuously involved. We shall first review certain facts previously stated and add certain additional ones concerning the way the nervous system is involved in activities of the glands and smooth muscles.

Rôle of the Nervous System in Internal Reactions

In Chapter II, it was stated that the glands and smooth muscles are thrown into action by neurones which form links between the smooth muscle or gland and certain centers called ganglia which are located in the body, outside of the central nervous system. At these centers, the neurones are connected by synapses with motor neurones which issue from the Central Nervous System.

This component of the nervous system is called *Autonomic Division.* It is called autonomic for the reason that, by means of local connections at the ganglian centers, many glandular and smooth-muscle activities go on without receiving specific stimuli from the central system. Thus many of the rhythmical activities of digestion, secretion and circulation possess a considerable degree of independence or "autonomy." The Autonomic System is not to be thought of, however, as an independent system. It is merely a component of the entire nervous system. It is connected, by synapses, with the Central Nervous System and consequently can be affected by nerve impulses received from it. The Autonomic System shows a unique type of organization, however, which we should understand in a general way.

The Autonomic System is divided into three groups of neurones:

(1) The *Cranial division* which is connected by ganglia with the upper part of the cord and mid-brain.
(2) The *Sacral division* which is connected with the lower part of the cord.
(3) The *Sympathetic division,* connected with the intermediate part of the cord.

Figure 18 is intended to indicate the positions of these three anatomical divisions. Although the Cranial and Sacral divisions are anatomically distinct, they have a similar function which is always antagonistic to that of the Sympathetic. The diagram is intended to show that practically all of the internal organs, as well as glands and smooth muscles near the body's surface, are supplied with neurones from the Sympathetic divisions, on the one hand, and from *either* the Cranial or Sacral on the other. The Sympathetic nerves produce one kind of reaction in a given organ and the Cranial or Sacral, as the case may be, produces an opposite kind of response. Thus, the Sympathetic impulse increases the activity of the heart whereas the Cranial decreases it. The Cranial increases the glandular and muscular activities of digestion in the upper part of the intestines, the Sacral in the lower, whereas the Sympathetic diminishes these activities in both regions. In general, if the Cranial or Sacral accelerates, the Sympathetic depresses; if the former diminishes an activity, the latter increases it; that is, they are antagonistic in function.

One other feature of Autonomic activity should be noted. The Sympathetic System, although tremendously complex, embracing nerves discharging into nearly all of the smooth muscles and glands in the body, tends to act as a unit. The innervations may be slight or profound but in either case the effects are widespread. Although the Cranial and Sacral divisions always oppose the Sympathetic, they do not work together invariably as a unit; they may send out various patterns of impulses. Thus they may arouse their typical responses more vigorously in certain organs than in others.

It should be noted furthermore, that while the organic activities can go on largely independent of specific control of the Central Nervous System, they may be influenced by nerve impulses issuing from the Central System. Some impulses from the Central System tend to accelerate the Sympathetic impulses, others tend to increase the Cranial and Sacral control in whole or part. This is the same as saying that situations which affect the Central System may also influence the Autonomic. Such situations as a loud noise, a painful blow, a tickle, a large coiled snake, an offensive remark, may tend to increase the activities of one or the other Autonomic functional divisions. Although such external stimulation is not necessary to keep the internal organs—the glands and smooth muscles—in action, they may increase, decrease, or alter their activities. A "response" of these internal mechanisms, then, is an increase, decrease, or alteration of activity. Such changes in internal activities of smooth muscles and glands may be either slight or profound; and they may be due to connections in the Central System which develop innately or which result from experience.

One further fact, stated in Chapter II, should be recalled. It was stated that the internal organs as well as the muscles, skin and other tissues are richly supplied with sense organs and sensory nerves. By means of these receptors, certain activities and changes in the internal organs can be experienced. That is to say, sensations may be aroused by the activities of the organism; one may "feel" or perceive changes in the activities in the skin, muscles, gland and inner organs generally.

DEFINITION OF THE TERMS FEELING AND EMOTION

As might be expected, the more profound the change in the activities of the body, the more vividly is it experienced or "felt." As a matter of fact, the ordinary, smooth-running, bodily activities, such as respiration, circulation, heart action, digestion, and moderate activities of skin,

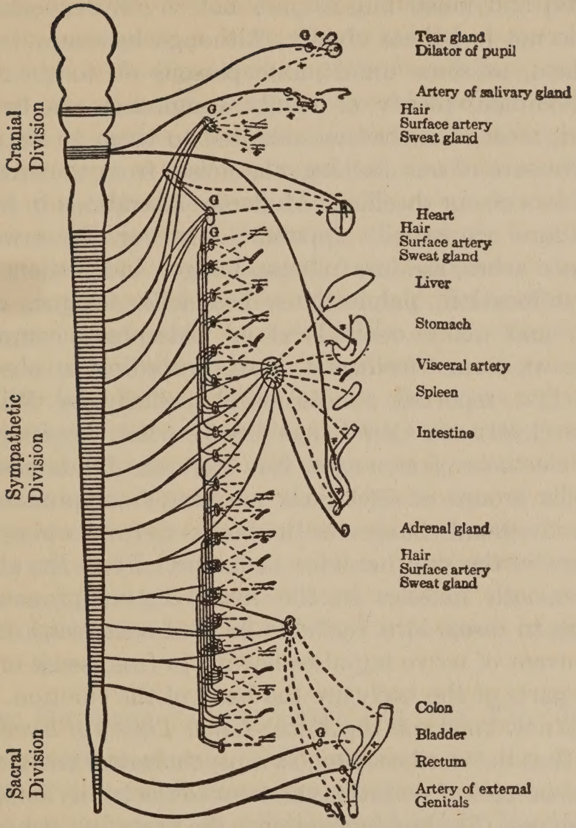
Cranial Division
Sympathetic Division
Sacral Division
G
Tear gland
Dilator of pupil
Artery of salivary gland
Hair
Surface artery
Sweat gland
Heart
Hair
Surface artery
Sweat gland
Liver
Stomach
Visceral artery
Spleen
Intestine
Adrenal gland
Hair
Surface artery
Sweat gland
Colon
Bladder
Rectum
Artery of external Genitals

FIG. 18.—DIAGRAM OF THE AUTONOMIC NERVOUS SYSTEM. The brain, mid-brain and spinal cord are indicated at the left. The solid lines running outward from the brain and cord represent the pre-ganglionic neurones. The dash lines are the autonomic fibers running from the ganglia to the inner organs. Note that the middle or *sympathetic* division has connections with all the organs represented; that the *cranial* division has connections with organs in the upper part of the body, the *sacral* in the lower. A + mark on the organ indicates an augmenting effect of the nearby fiber, a — mark indicates a depressive or inhibiting effect. The *sympathetic* is antagonistic in function to the *cranial* and *sacral* divisions. (From W. B. Cannon, *Bodily Changes in Pain, Hunger and Rage*, by permission of D. Appleton & Co.)

skeletal and facial muscles are not vividly experienced. We do not feel them vividly. Although by concentration on them, as some unfortunate persons do to their own disadvantage, plenty of bodily symptoms can be perceived, most of us become adapted to them as we do to the pressure of our clothing, the noises from the street or the odors of our dwelling. Moderate alterations in bodily conditions are usually apparent, however. Thus we experience aches, strains, fullness, hunger, indigestion, nausea, suffocation, palpitations, headache, fatigue, chills, fever, and many other local or widespread complexes which we term "feelings." Now, according to observations first reported almost simultaneously by William James (1884) and Carl Lange (1885), what we commonly term *emotions*—fear, anger, joy, etc.—are fundamentally complex groups of sensations resulting from pronounced and widespread changes in the body. Certain widespread changes in the skin, muscles and especially in the glands and smooth muscles in the inner organs pronounced enough to result in a veritable flood of sensations due to the torrent of nerve impulses flowing in from sense organs in all parts of the body are the basis of the emotion. The view is now known as the *James-Lange Theory of Emotions.* Note that the word *emotion*, as a psychological term, refers to the complex of sensations and not to the bodily activities themselves. The bodily reaction is the first step, or basis of the emotion, but the emotion itself is the blend of sensations which the bodily response occasions by stimulating the thousands of sense organs which are contained in the body.

EMOTIONS CONTRASTED WITH OTHER COMPLEXES OF SENSATIONS

The term emotion, however, is not applied to the feeling of relatively simple or readily localized activities such as hunger, thirst, the burning or gnawing of indigestion, nausea, or palpitation of the heart; nor do we speak of a single type of bodily sensation, however diffuse, such as general muscular fatigue, fever, or chills as an emotion, although the latter are approximations. No, the genuine emotions, such as fear and rage, are much more diffuse, mixed, unanalyzable groups of sensory qualities. They represent changes which pervade the whole body, and among them the smooth-muscle and glandular changes which are controlled by the Autonomic Nervous System are most conspicuous. In fact, unless an experience possess a considerable organic reverberation—strained or irregular breathing, palpitations of the heart, flushings and palings, quivers, sinking feelings in the stomach, tensions of the arteries, and other changes especially in the viscera—we do not use the term emotion at all. The sensations found in emotions come from changes in sense organs and skeletal muscles as well as from internal organs, however, and with these outward visible "expressions" we shall deal first, before turning to the more important organic changes.

The Outward "Expressions" of the Emotions

We recognize general bodily postures that are characteristic of certain emotions: we speak of being rigid with fear, bent with grief, or puffed up with pride. The expressions of the emotions appear more uniformly in patterns of response of the facial muscles. That many of them have an instinctive basis is suggested by the fact that they are, so far as may be observed, universal and fairly constant reactions. Studies of infants (as by Gesell) show characteristic sequences in the appearance of many such forms of response. If the reader will observe Figure 19, he will be able to identify many of the emotions "expressed," although the face is unfamiliar, and much, such as color and movement, is lacking. It should be added, however, that human beings soon learn to inhibit the normal expressions and even to supplant them by contradicting ones, such as smiling pleasantly when angry. It should be stated further that many patterns of facial expression are acquired as means of social intercourse; we learn to make the expressions most suitable to the social situation. Thus native dispositions are soon distorted and controlled.

The facial expression may serve the purpose of influencing the behavior of other organisms. The display of teeth, and other angry expressions along with hissing, growling, barking, etc., may be conceived as instinctive forms of "bluffing" which may frighten off smaller or less courageous opponents. Note the transformation in size and ferociousness of appearance of a cat when menaced by a strange dog. Similarly the human expressions of derision, scorn, disgust, may modify the acts of others. Smiling, or a "sad expression," although the origin is obscure, invites kindly and sympathetic behavior. The erect, puffed-up attitude of pride may beget admiration or submission.

The wide-open eyes in wonder or surprise are an adjustment which provides a wide range of vision. The narrowed eyes in anger provide a visual concentration on the object of attack, while the puckering of brow and closing of lids serve to protect these vital organs from injury. The slowing of breathing, in the first stages of fear, provides for more adequate hearing. Sniffing and pricking up of the ears in animals are sensory adjustments to slight stimulation. Much of the expression of an emotion, then, is the result of sensory adjustments.

Gritting and display of the teeth in anger among animals are motor adjustments for attack. Human beings, under primitive conditions, may have used their teeth as weapons; the tenseness of muscles about the jaw is a result probably of these adjustments. The widened nostrils in fear or anger permit more effective breathing; clenching the fists and other muscular tensions have obvious utility. The bristling of hair about the neck and other preparatory reactions of animals belong here too. The turning aside and wry face in disgust probably originated in the infant's response to undesired food or to noxious odors. The expressions under emotion, then, are in part the results of adjustments for motor response to the exciting object.

The outward expressions of the emotions, depending mainly on the patterns of response among the skeletal muscles, large and small, show an almost unlimited variety. Figure 19, for example, gives only a small sampling of the many facial expressions which this one subject made. Patterns of general bodily adjustments brought about by different stimuli are also very numerous. This fact will appear to be of considerable importance later in attempting to disclose the bases of an alleged large number of different emotions. It will be found that while the skeletal "expressions" are numerous and distinctive the types of visceral responses, depending on the smooth muscles and glands, are few.

INTERNAL CHANGES IN THE EMOTIONS

The facial and bodily postures assumed during emotions are numerous. Perhaps few in the average adult are native; most are the results of experience in which new patterns of response have been learned, and the original ones dissociated from the emotion actually felt. Thus one learns not to show his feelings. It should be recalled, however, that the facial and skeletal muscles are not under the control of the autonomic system which tends on the whole to work in units. We shall turn to the internal changes, which are by far the more pronounced and vital phase of the organic response that evokes the complex of sensations to which the term emotion applies; we shall consider first the changes which occur in fear, anger and certain related emotions.

Fear, anger and certain other "strong" emotions are found to go hand in hand with those internal changes brought about by stimulation of the sympathetic division of the autonomic system. Certain important internal changes, representing a well-knit unity, result from autonomic stimulation and are therefore found during fear and anger. Marked changes in the digestive and assimilative functions are brought about. If a cat which has been fed a meal of gruel containing bismuth, a substance opaque to X-rays, is placed before the screen of an X-ray apparatus, the normal rhythmic, churning movements of the stomach may be clearly observed. If the cat is angered by a barking dog, these movements may be greatly diminished; in fact, they often cease altogether. Even in milder vexation, such as that produced by tying a small stick to the cat's leg, the stomach movements may be inhibited. The glandular activities of digestion are similarly diminished. In a typical experiment on an angered dog, instead of the usual sixty-five or seventy cubic centimeters of gastric juice, an amount less than nine cubic centimeters (and this of poor quality) was secreted. Thus the whole digestive process is sidetracked.

What purpose could all of this serve? None is very apparent save this—the elimination of the work of digestion liberates a good deal of energy that may be otherwise utilized. That such energy is conserved for strenuous muscular action is probable.

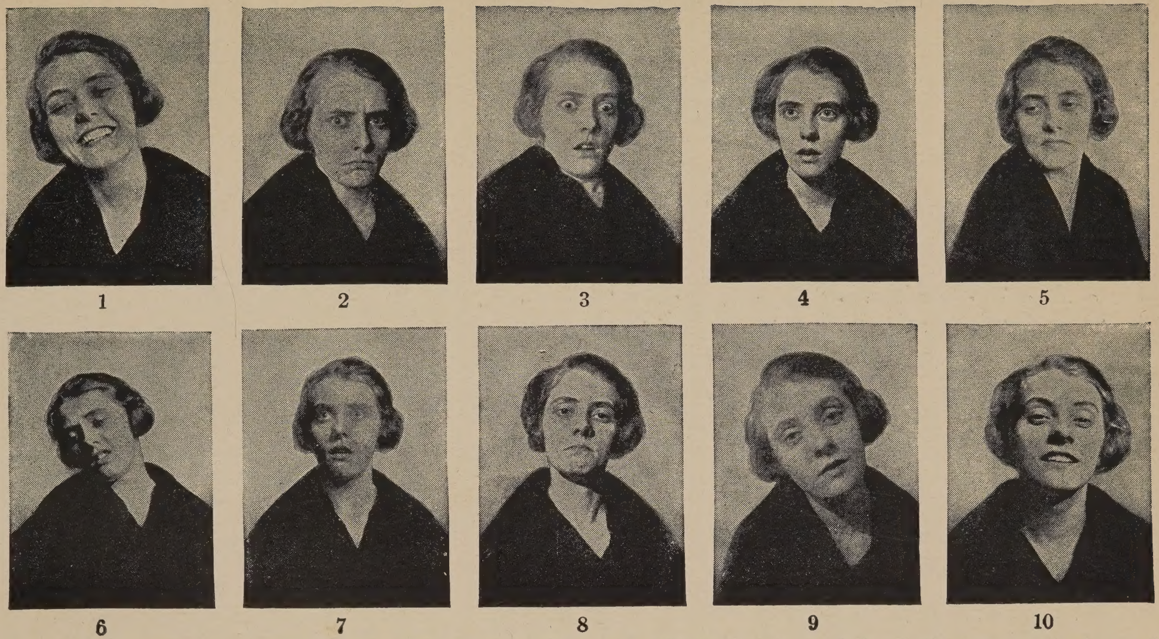

FIG. 19.—REPRODUCTIONS OF TEN FACIAL EXPRESSIONS. Try to identify them, using such descriptive terms as "unhappy," "surprised," "frightened," etc. (From G. S. Gates, after Ruckmick.)

With anger or fear go also pronounced circulatory changes due to sympathetic discharge. The heart beats more rapidly and with greater amplitude. The arteries of the abdomen are constricted, thus driving large amounts of blood to other parts of the body, mainly to the skin, skeletal muscles, brain and lungs. The constriction of arteries, together with increased heart action, produces a higher blood pressure and more effective circulation through the organs involved in bodily action.

The lungs are stimulated to greater activity; breathing becomes deeper and more rapid. Sweat breaks out on the skin, making an early start toward the elimination of heat from the body engaged in strenuous exertion. The sympathetic fibers also activate the adrenal glands whose secretion, adrenalin, poured into the rapidly circulating blood promptly reaches the various bodily organs and profoundly affects many of them.

Like the impulses of the sympathetic system, adrenalin diminishes the glandular and muscular activities of digestion, constricts the abdominal arteries, and stimulates the heart and lungs. It increases and prolongs the more prompt effects of the sympathetic nerves and produces several additional changes. Reaching the lungs, adrenalin causes a dilation of small smooth muscles, which permits more ready ventilation, and thus provides for a more speedy assimilation of oxygen and discharge of the products of fatigue. Adrenalin has a specific effect on skeletal muscles, greatly increasing their sensitivity to nerve impulses, which results in greater strength and endurance. Adrenalin causes the liver to pour into the blood more rapidly its store of blood sugar, the fuel which is burned in muscular work; it also causes the liver to secrete a substance which makes blood clot more rapidly on reaching the air, thus reducing the flow in case of an injury.

THE EMERGENCY THEORY OF THE EMOTIONS

Other organic changes, characteristic of fear and anger, could be mentioned; but this, at least, is already apparent —the body is adjusted during such emotions to provide for the greatest muscular strength and endurance. On the basis of this fact, an American physiologist, W. B. Cannon, has framed what he calls *The Emergency Theory of the Emotions*. The sympathetic system is conceived as an elaborate check-and-drive mechanism that is thrown into gear by events which demand immediate and energetic action; that is, by emergencies. Under primitive conditions, loud or sudden sounds, the perception of wild beasts, unfamiliar men, obstinate obstructions and other objects or conditions which arouse fear or anger, represent situations in which physical strength and endurance, as in the fight or flight, may enable the organism to survive. It matters relatively little that digestion is inhibited, the heart or lungs overworked, if the animal successfully meets the emergency.

The organic responses, then, are preparatory reactions —elaborate mobilizations for violent and prolonged physical action. The emotions of fear and anger are, in the main, the sensations occasioned by these inner changes.

TYPES OF EMOTIONS

The sympathetic system, it is said, is antagonistic to the functions of the cranial and sacral autonomic. Innervations of the latter tend in general to promote the quiet, normal organic processes of digestion, assimilation and excretion—the quiet service of building up bodily resources. Stimulation of certain nerves of the cranial division increases the flow of saliva and gastric secretions, dilates the blood vessels of the viscera and promotes the action and tone of the stomach and alimentary canal.

Other nerves of this division slow the heart, thus resting the cardiac muscles. Certain nerves of the sacral division are concerned with the proper regulation of the bladder and the lower alimentary canal.

Innervation of the visceral organs by the cranial and sacral nerves tends to arouse quiet, pleasurable emotional states for which we have but few names. A comfortable state of "well-being" is about all there is to it at times and the mild emotions of mirth, of pleasure in hearing music, of joy in one's work, in agreeable conversation, comradeship or surroundings, harmonize with the upbuilding internal services of the body. These we shall call the mild joyful emotions. Under such mild but joyful mental states we are best fitted for most of the tasks of daily life.

A portion of the sacral division of the autonomic system is concerned with stimulation of the sex functions. Such stimulation activates a number of muscular and glandular functions, in various degrees of intensity, which result in a complex of vivid sensations. These sensations are the primary factors in certain experiences of an emotion-like character that we shall call the *sex emotion.*

The Three Types of Emotions.—Three general types of inner responses have been found. Each furnishes in all probability the fundamental basis of an emotional experience. The three types are:

(1) The strong, "emergency emotions," depending on the discharge of the sympathetic divisions of the autonomic system. Since the sympathetic division acts as a whole, such emotions must be organically much alike. They may, however, differ in degree from very slight to very great intensity.

(2) The mild, joyful, upbuilding emotions, depending

on the activity of the sacral and cranial divisions of the autonomic nervous system. The sensations thus provided are usually mild and inconspicuous. Since they arise from the normal healthful bodily functions they are often not thought of as emotions at all. We shall refer to them, however, as the mildly joyful emotions.

(3) The sex emotions, including lust, depending on certain activities of the sacral system. Presumably there are several types of sex sensation-complexes. Some of them vary in degree from slight to great intensity.

Aside, then, from the sex emotions and the mild, pleasurable states of well-being which go with the action of nerves in the cranial and sacral autonomic, all other genuine emotions, so far as is known, result from innervations of the sympathetic system.

Subdivisions of the "Emergency" Emotions.—We are at present unable to give subdivisions of either the mild pleasurable emotions or the sex emotions. The emotions which are known to go with sympathetic action may, however, be listed in several groups. Since we shall be mainly concerned with these, a fourfold classification is presented.

(1) Anger, and other similar states, such as rage, fury, vexation, irritation, revenge and perhaps jealousy and scorn.
(2) Fear, and similar states, such as dread, anxiety, worry, melancholy, terror and perhaps grief and regret.
(3) Excitement, shock, uneasiness, nervousness, embarrassment.
(4) Extreme pity, sympathy, elation, enthusiasm.

Anger and Fear.—It is assumed that the several states which are classified with anger, *i.e.*, rage, vexation, etc., are more like each other than they are like fear or any of the states similar to fear. It is not assumed, however, that the experiences in the angerlike group are wholly unlike those in the fearlike group. What, then, are the precise similarities and differences?

All of those inner changes brought about by the action of the sympathetic system are to the best of our knowledge essentially the same except for differences in intensity or degree. The sympathetic system acts as a whole and it acts essentially in the same way in anger, vexation, jealousy, fear, or anxiety, except that there is more intensity in some states than in others. Since the inner changes in smooth muscles and glands are the basis of a very conspicuous part of the complex of sensations which makes up an emotion, all such emotional experiences have much in common. Introspectively, this seems to be the case. The fundamental feature of all these strong emotions is the flood of sensations—a sort of excitement and turmoil—aroused by impulses from the smooth muscles and glands. Studies of very young infants (by the Shermans) show, in fact, that it is most difficult to distinguish fearful from angry or irritated behavior by means of observing the crying, the muscular or other reactions.

Most adults, however, find the experience of "being afraid" very different from "being angry" or "being excited." Upon what do these differences depend? Being "afraid" or "angry" or "excited" are very complex experiences which include components other than the sensations from functions controlled by the sympathetic system. They include, in the first place, a certain pattern of response of the skeletal musculature. Each has its particular facial expression and its specific arrangement of muscular tensions, inhibitions and relaxations in the hand, arms, trunk, legs, feet. Note the differences in all of these external muscular patterns in men in fear, anger, grief, etc. Each such pattern of motor response arouses a particular complex of sensations; each "feels" different from the others. In part, then, the observed differences between anger, anxiety, fear and the others are due to the variations in the patterns of adjustment of the skeletal muscles. This, however, is not the only difference.

The percepts of the exciting objects differ greatly in the several experiences. In fear, it is perhaps a wild animal; in anger, an annoying intruder; in excitement, a critical audience that is perceived and thought about. The impulses experienced in different emotional experiences are very unlike. In fear are felt strong impulses to escape; in anger, impulses to attack or injure in some way. These urges are usually vivid during emotional crises and they contribute greatly to differentiating the experiences of "being afraid," from "being angry," etc. These impulses are not, strictly speaking, parts of the emotion. They are components of the total experience at the time but really not a part of the emotion itself.

The organic turmoil which is the main component of the emotion, then, is essentially the same in all strong emotions except lust. The skeletal musculature, sensations from which form a component of the genuine emotion, takes different patterns in various emotions. Fused with these are non-emotional experiences, namely, the percepts, judgments, apprehensions, ideas of all sorts and the urgent impulses which differ greatly in various emotional experiences. Care must be exercised, therefore, to indicate clearly which of the several components of the emotional experience one has in mind during discussion.

Shock and Excitement.—Violent inner shock (which is due to very intense sympathetic innervation) or excitement represents the sheer organic changes very well, since the impulses are often vague and uncertain. Excitement thus resembles both fear and anger organically, but differs from both because of the indefiniteness of the impulsion. For example, a sound heard by a primitive man prowling in the woods might have aroused the sympathetic activities, experienced as excitement or uneasy alertness, until the source is more clearly perceived. If the stimulating object is found to be a ferocious beast, the percept with the impulse to run, added to the organic and muscular adjustment, constitutes the whole experience of fear; if the stimulus proves to be an old enemy, that percept plus the impulse and a muscular arousal to fight constitutes the state of anger. The inner changes themselves, devoid of percepts, ideas, impulses and muscular adjustments, are felt as various degrees of inner turmoil ranging from terrific shock to slight excitement.

Exciting Joy, Enthusiasm, etc.—The violent or exciting states of mirth, joy, pity, zeal, enthusiasm and the like are included in the list of emotions which depend upon the activity of the sympathetic system. Suppose, for example, that you are quietly enjoying a concert. If the music becomes very stirring, you may experience a glow, a pang in the breast, a fullness of breathing, a flutter of the heart, a shudder or darting chills, a sinking sensation in the region of the stomach—evidence of the discharge through the sympathetic. Joy, on other occasions, may become so violent as to produce weeping, labored breathing, high blood pressure, and digestive disturbances. Enthusiasm, especially in people of the emotional or excitable type, may become so exciting as to make quiet work or thought impossible. Thus, in the intense, exciting, or violent form, joy, enthusiasm, pity and others belong in the sympathetic group.

Other Alleged Emotions Are Mental and Motor Attitudes.—In addition to the intense emotions of the exciting type, the sex emotions and the mildly pleasant states which accompany the organic and visceral processes of the normal and upbuilding types, the language abounds with names of conscious states which common usage treats as emotions—wonder, timidity, gratitude, admiration, suspicion, coyness, pride, hope. Most of these are really not full-fledged emotions unless, like joy or enthusiasm, they take on the elements of marked excitement. In mild form they are impulses and general attitudes without the marked organic turmoil which is the essence of the strong emotions.

Having selected certain fundamental type emotions and described some of their constituents, we are now ready to consider whether they are native or acquired and if native what situations tend instinctively to produce them.

ARE THE EMOTIONS NATIVE OR ACQUIRED?

Observations of infants soon after birth have given convincing evidence of the native character of significant symptoms of typical emotions. Facial expressions, bodily adjustments, changes in breathing and circulation and other characteristics of the fear-anger group may be evoked almost immediately after birth. These symptoms indicate sufficiently the arousal of the sympathetic system. In animals, too, the elaborate internal changes appear very early. The emotions depend on complex patterns of response that are fundamental and native. Evidence of joyful experiences also appear very early. They will, therefore, be considered as fundamental and instinctive responses. Some evidence of the sex emotions is found in infancy although the glandular mechanisms essential to the profound sexual emotions are not functioning completely until pubescence. That the inner adjustments which form the main components of these emotions are acquired is altogether unlikely. They show a complexity of coördination that seems intelligible only when conceived—like fear, anger and joy—as instinctive.

Situations Which Instinctively Arouse Fear and Anger.—The machinery of the main emotions and the coördinated character of its operation in each case are native, but what situations instinctively activate these remarkably complex reactions? A complete answer to this question cannot be given at present.

Fear (according to Watson) occurs in infants as a response to:

(1) Sudden removal of support, as when the hands are withdrawn, allowing the infant to drop a few inches before being caught.
(2) A sudden push or shake or movement of blankets, etc., when the infant is sleepy.
(3) Loud sounds.

When greater maturity is reached, probably other stimuli instinctively arouse fear but the evidence is not complete. It is believed (by Thorndike) that at appropriate periods in life each of the following alone, or at least in combination with other factors, arouses fear: thunderstorms and other loud noises, solitude, darkness, being suddenly brushed or clutched, strange persons of unfriendly mien, large animals approaching one, reptiles and certain vermin. Very young infants betray no instinctive fear of animals. Whether the fright which makes its appearance later is the result of animal stories or other experiences or due to the ripening of a delayed instinctive tendency is not as yet certain. Essentially the same uncertainty prevails concerning some of the other sources of fear.

Anger is a reaction that seems to be instinctively aroused by a very large number of stimuli. The infant is angered by almost any persistent hampering of his movements, even by slight constraints put upon the head by soft pads. As the child grows older, it seems natively disposed to become angry whenever any activity under way—eating, sleeping, sitting still in thought, walking, etc.—is persistently interrupted or interfered with. Being slapped or otherwise pained, being shoved or seized, are types of interferences that are especially likely to arouse anger from the earliest stages of infancy.

The situations which arouse fear and anger in the main represent *emergencies*. Under conditions of primitive life these emotions were activated instinctively by conditions in contending with which increased bodily strength and endurance would be of great utility. Mankind to-day possesses the same emotional equipment that thousands of years ago helped its ancestors to survive. At least, modern biology tells us that the physical, emotional and mental equipment of people to-day is almost imperceptibly different from that of mankind ten or twenty thousand years ago. The emergency theory of the emotion gains support both from a consideration of its survival value in the race and from the study of the native responses of infants of to-day.

Situations Which Instinctively Arouse Joyful Emotions.—Joyful emotions of the mildest sort accompany the smooth-running, undisturbed bodily processes. They are the result of sensations produced by such organic functioning. They may be heightened in infants by such stimuli as feeding when hungry, removing from a hard to a soft bed, warming up when cold and by certain tickling, shaking, rocking, patting, turning about and other forms of attention. Among adults enjoyment results from innumerable situations and it has not been possible to distinguish the native from the acquired sources.

Laughter, the clearest objective symptom of a joyful emotion in most children and adults, has been the subject of many volumes of speculation, but as yet no satisfactory account of the essential factors which produce it at any time has been produced. Many native sources of joyful emotions remain obscure. This much seems clear, however, perfect operations of the cranial-sacral functions, that is, fine digestion, assimilation, etc., result in a strong predisposition toward joyfulness and laughter. The child well fed, healthy, functioning excellently, laughs and is joyful for almost no other reason at all.

The Sex Emotions.—Some students (*e.g.*, Freud and Watson) have concluded that the joyful emotions and the sex emotions are really the same. Usually such students assume that all forms of joyful emotions are really sexual in character. This notion seems to be incorrect. Everyday experiences and introspective study will disclose unique characteristics of forms of mirth, laughing, joyfulness and bodily exuberance that are unlike lust or any form of sex emotion. The sexual functions, moreover, are controlled by fibers of the autonomic system which may act independently of the other fibers of the sacral and cranial division. These are sufficient reasons for treating the joyful and the sexual as distinct emotions.

The only way of arousing, instinctively, the sex emotions is the stimulation of certain erogenous zones. It is maintained by some that a specific sex emotion may be thus aroused in infancy. Probably a complete sexual emotion cannot be aroused until pubescence and, then, most readily, when the organic condition is favorable. Lust, among adults, may be aroused in innumerable ways as may fear, anger, or joy, but by situations whose connection with the emotion is acquired. How emotions, themselves native and instinctively aroused by relatively few situations, become attached to new stimuli will be disclosed in Chapter VIII.

Of the three general classes of emotions, most is known about those which depend on the action of the sympathetic system. Since these are of great significance in everyday life, some attention will be given to them in their relation to motor and mental efficiency, to health and to other conditions.

Some Effects of Fear, Anger and Similar Emotions

Fear, anger and the other emotions of this class, controlled by the sympathetic system, are preparatory reactions in the form of mobilizations of organic and visceral resources for the maximum physical exertion. Under conditions of primitive life in the jungle, their utility in contending with human or animal enemies, with storms, floods and natural forces would be apparent. In modern life, they may be of service in similar exigencies, but ordinarily they begin and end without the physical exertion for which they are a preparation. We are often angry, but seldom fight; often fearful, without flight.

On Health.—What are the results of emotions, such as rage, anxiety or fear, when they are not accompanied or followed by physical exertion? Indigestion is one result. The angered cat showed stagnation of food in the stomach from three to six hours on different occasions. Among humans anger, excitement, sorrow and extreme joy are often followed by more or less severe digestive disturbances. Loss of appetite and weight under prolonged sorrow, anxiety, or worry is often observed. The blood sugar liberated by the liver when not utilized as muscular fuel is partly wasted by excretion through the kidneys. The general wear and tear on the heart and arteries, the adrenal and other organs which are driven to excessive action during the strong emotions, may in the long run be injurious. At least, it is widely believed that the excitement, worry, fear, anger and irritations of life hasten the breakdown of the visceral functions and it is well known that diseases or deficiencies of these functions are greatly aggravated by emotional disturbances.

When asked on his eighty-ninth birthday for the secret of his longevity and vigor, Charles W. Eliot, President Emeritus of Harvard University, is reported to have said: "My experience does not furnish a short explicit prescription of keeping health and working power till eighty-nine. I will say, however, one thing seems highly important—*keep as calm under all circumstances as your nature permits.*"

On Skill, Thought and Ability to Learn.—However greatly crude strength may be increased under the strong emotions—anger, fear, or excitement—efficiency in acts of skill, in judgment and reasoning, and in learning is decreased. The excited or angered baseball player fumbles the ball. The frightened youth forgets his "piece." An inventory of the experiences of skilled musicians disclosed an almost universal conviction that any exciting emotion aroused by the audience, or even an emotion normally aroused by the music itself, is detrimental to proficiency. Even in boxing, where strength assuredly counts, it is well known that skill is disrupted by rage. In golf, tennis and other sports requiring great precision, the disastrous effects of anger, chagrin, nervousness and anxiety are patent.

Thinking, reasoning, judgment are, like skill, disturbed by the strong emotions. In melancholy, ordinary tasks or debts look herculean. Frightened by a cry of "Fire!" the audience falls into an irrational panic; the drowning man strangles the swimmer who attempts to rescue him. Even for murder, the leniency of the jury is generally assured if the act was committed in a passion. Violent emotions represent, in effect, internal preparations for violent acts, and often the less intense grief, fear, vexation, or excitement may lead to thoughts, words, or acts that seem unwarranted or ridiculous in calmer moments. In laboratory studies, although violent emotions are seldom secured, the general tendency of the milder ones to disturb acts of thought or skill appears clearly. Such tasks as tracing the outline of a pattern which is observed only by reflection from a mirror (mirror-drawing) or performing a difficult feat in mental arithmetic are retarded and sometimes disrupted by vexation, anger, chagrin, anxiety, or even by too exciting enthusiasm. It is characteristic of the novice to be subject to frequent emotional upsets. As the learning progresses, greater poise is achieved. Generally speaking, the highly efficient performance is characterized by a quiet alertness and unemotional zeal rather than by excitement or emotional enthusiasm. There are, however, many mental and motor functions such as writing, simple arithmetic, etc., so well habituated as to withstand very considerable emotional disturbances.

On Stimulating Activity.—The notion that the strong emotions in the routine of life render a tremendous service by providing impulsion to greater accomplishment, that they represent the release of hidden springs of energy, is likely to be very misleading. That they do provide a temporary increase in muscular strength we have seen, but this is attained at no small cost nor can it be long maintained. The athlete may run his quarter mile better if excited (although many prefer to be calm), but if he is "on edge" too long before the race, he may be half exhausted before it begins. The depleting effects of a public performance by the uninitiated, of a frightful or grievous experience, are familiar to all. "What," asks David Belasco, "would be the condition of a player who, every night for even one week, should really feel all of the emotions of Hamlet or Othello or Lear; of Queen Margaret or Lady Macbeth or Juliet?"

But is the strong emotion not of great utility as an occasional upheaval to arouse us out of complacency to fresh resolution and determination, to set the ball rolling? If a student feels he is losing his interest in his studies—going stale—would not the part of wisdom be to arouse somehow in himself profound disgust, or anger at his lethargy, or vivid excitement by anticipation of the rewards of greater achievement? It would seem so; and perhaps the answer would be affirmative if there were no better ways. The physician often faces a similar situation. The patient reports bodily sluggishness and loss of grip. While pills or stimulants may be prescribed, the physician knows they are but temporary expedients which work no permanent cure. The remedy lies not in drugs but in better hygiene; better habits of eating, sleeping, work and play. The remedy for mental inertia is not in emotional stimulation but in improved habits of mental hygiene. A strong emotion, acting like a drug (for adrenalin and other glandular secretions are drugs), has the habit-forming effects of such artificial stimulation. If we rely upon coffee to keep us awake, shortly coffee is required in increasing doses. If we rely this week on emotional outbursts to get us at our tasks we shall the more surely require them the next. The emotional upheaval is like a drug, strictly an emergency measure, to be used only as a last resort, and then advisedly.

CONTROL OF THE EMOTIONS

Evidence of Marked Control.—Admitting that the strong emotions are not essential but usually detrimental to the achievements of modern life, are they not essential to certain tasks, such as pleading in court, preaching and other public performances? Could one make a stirring address without being stirred himself or, what would seem to be more difficult, could one portray an emotion without really experiencing it himself? The testimony of great actors and actresses should furnish an answer to this question.

Many years ago, William James collected the statements of a number of leading actors and actresses and found a division of opinion. Many of the greatest were able to portray perfectly the outward appearance of emotions in face, posture, gait and voice without the visceral and organic accompaniments on which the emotion chiefly depends. Others believed they were unable to affect the dissociation so completely. The few cases, however (if they are correct observations), are enough to show that the inner turmoil is not essential to successful dramatization.

David Belasco, the eminent theatrical producer, has a decided opinion on the matter. "To assert that any actor must or even can really feel, when acting, all that he represents—assuming, of course, that he is representing any vital or even vivid emotional experience—is merely to maintain what is manifestly nonsensical. In acting, there never can be, in the very nature of things, any real feeling. . . . Nowhere are complete self-control, dominion, poise more absolutely essential to success than they are in acting and they cannot exist where sensibility is permitted to hold sway."

Mr. Belasco cites a number of anecdotes in support of his belief that great actors, even in playing profoundly emotional rôles, really maintain perfect self-control. For example: "One night when playing Othello in America, Salvini, as he spoke the final words, 'no way but this, killing myself to die upon a kiss,' and collapsed in his appalling simulation of death, murmured to Miss Viola Allen, the player of Desdemona: 'For the one hundred and third and last time this season!'"

The Need of Control of the Emotions.—While it is possible, as actors and actresses testify, to portray the facial, bodily, and vocal features of an emotion without the inner turmoil, the more frequent modification in everyday life is the elimination of the outer expression, while the internal disturbances hold sway. We experience anger, fear, or sympathy without obvious motor response. Indeed, the emotions may come to be highly satisfying, as in the case of the few who greedily study the daily paper for fresh incentives to grieve idly at the world's sufferings, rage at its vices and exult at its achievements without contributing in any way to the relief of suffering, to the abolition of vice, or to the increase of achievement. The emotions might be defended on the ground that they are intensely satisfying, that they add to the color and variety of life and break up the drab monotony of routine. It would be a sorry world for most of us were there no indignation, exaltation, or excitement; even fear, anger and grief—under certain circumstances—are satisfying. If we can experience these emotions with little likelihood of serious consequences, as we may enjoy fear in a storm-tossed ship if assured of safety, or anger and grief from scenes on the stage or screen, it is undeniably pleasant, as our willingness to pay substantial prices for these experiences amply attests. What is needed, of course, is temperance and wise control. The main dangers lie in the possibilities of permitting emotional enjoyment to become debauchery or a substitute for action. Not only are worthy impulses and attitudes with less internal turmoil more desirable from the standpoint of personal efficiency and health, but the world is better served by acts of relieving suffering and resisting oppression than by reactions which begin and end wholly in one's breast.

GENERAL EMOTIONALITY

Individuals differ in their general emotional responsiveness. At the one extreme are the calm, stolid, imperturbable individuals; at the other the excitable, sensitive and easily aroused; and from one extreme to the other we pass through degrees of emotionality insensibly minute.

The concept of general emotionality is not unlike the concept of general athletic ability, general strength, or general mental ability. Two people at approximately the same stage of emotionality are not necessarily identical, but are like two people of about the same general athletic ability, who are alike only on the average, while different, more or less, in each of many particular forms of athletic prowess. Averaging up the emotional reactions to many situations, we arrive at a rough central tendency and it is to this that the term general emotionality refers. The cases of great general emotional susceptibility, or of great emotional lethargy, need not represent particular defects in one's equipment but merely the extremes of a group of tendencies possessed by all.

Emotional Excess.—An excess of emotionality is the main characteristic of one extreme. All or nearly all emotions may be excited by stimuli, numerous and slight, more than is the case with average people; joy, fear, sorrow, melancholy and excitement are easily and frequently aroused. Not only are emotions easily and often excited, but they are usually intense; joy is for them often explosive and riotous, anger becomes violent rage, sorrow becomes intense grief.

While there are individuals predominantly sorrowful, or mirthful, or easily angered or affrighted, the more typical case is the individual who is susceptible to all or nearly all forms of emotional response. As a general rule, the person readily susceptible to one form of emotion is readily susceptible to others. The child who laughs the heartiest, most readily breaks into tears; adults capable of the most enraptured pleasure are susceptible to the deepest sorrow or the most exquisite pain. The most readily enraged may be, in turn, the most compassionate; the most ferocious, the most fearful. The sympathetic system, in all of these cases, seems to be hypersensitive and hyperactive; easily thrown into gear and usually intense in its response to stimuli of many sorts.

Emotional Instability.—Usually, but not invariably, extreme emotional sensitivity is characterized not only by emotional excess but also by emotional instability. The emotional person often shifts abruptly from laughter to tears, from affection to anger, from self-confidence to pessimism. In this fickleness, the emotional sensitivity and excessiveness of response can usually be recognized, despite the fact that other types of instability, more mental than emotional in character, making up what is called the "psychopathic" or the "neurotic" constitution, are frequently found in the same individual. Indeed, excessive emotionality and nervous and mental instability are often difficult to distinguish. Of the latter, something will be said in Chapter VII.

The extremely unemotional individual is less easy to detect and his behavior is a less serious matter with the exception of the infrequent cases caused by actual disease. The least emotional individuals are by no means unemotional, but are aroused less frequently and less intensely. The mechanism of the emotions, designed for emergencies, is rather easily aroused even in those relatively unresponsive. It is the overemotional rather than the underemotional who experience difficulties in adaptation to modern conditions.

Handicaps Produced by Excessive Emotionality.—In the emotional child the sympathetic nervous system, it would appear, is readily innervated, bringing about the train of visceral changes previously described. How serious these disturbances may be depends, of course, upon the soundness of the organs themselves; but indigestion and intestinal disorders, disturbances of circulation and of heart action, nervousness, insomnia, general weakness and fatigability are frequently found. With the internal activities of the body more than commonly at the mercy of the external conditions, more than ordinary care and prudence must be exercised to avoid overtaxation of reserves. The emotionally unstable child usually cannot indefinitely keep pace with those of greater poise but otherwise of equal endowment.

In the work of the school, the handicap of excessive emotionality usually becomes apparent. Pupils of high mental abilities who are otherwise sound, except that they are very emotional, experience difficulties in holding themselves down to continuous, especially monotonous, work. Drill in spelling, arithmetic, phonics and writing may be carried on sporadically. In the formal aspects of these subjects the emotional child lags behind his intellectual possibilities. He lacks the capacity for steadiness and persistence of concentration which such functions demand. His attention may flag and shift before the lesson is well under way. Special interests, more individual attention, shorter periods of practice with frequent change, an abundance of physical freedom and other special forms of treatment frequently enable the emotional child to make greater achievements. In some, excessive sensitivity of the sympathetic system is a handicap demanding special management and hygiene as much as deficiencies of the lungs or muscles or heart.

FEELINGS

Emotions, we have seen, are complex patterns of sensory qualities aroused by the widespread stimulation of sense organs in the body. There are many other patterns or blends of sensations resulting from more restricted internal activities which are called *feelings*. Hunger, nausea, fatigue, soreness, fullness, etc., are examples of feelings. The term *feelings* as here used, refers to the perception or becoming aware of conditions, activities, or disturbances in the body which arouse internal sense organs. Most of these feelings deserve no extensive treatment for the interests of students of education. But two feelings, or rather a pair of complementary feelings, do merit attention. They call for discussion for the reason that they seem to be conscious experiences which go hand in hand with two fundamental adjustments of the organism that play a very significant rôle in directing the process of adjustment and learning. These two feelings have historically been termed *pleasantness* and *unpleasantness*.

Characteristics of Pleasantness and Unpleasantness.— It is difficult to describe the feelings of pleasantness and unpleasantness. One can understand what is meant by them only by observing the experience which usually accompanies the taste of sweet as compared to that which goes with bitter, or noting the pleasing experience produced by a musical selection as contrasted with the unpleasantness produced by the screech of a file, or the agreeableness which is brought by flattery as contrasted with the disagreeableness which may follow reproof.

These feelings must be distinguished from mere awareness of certain sensory qualities with which they are readily confused. Unpleasantness in particular is often confused with sensory pain. Pain is a definite type of sensation-quality occasioned by the stimulation of a particular kind of sense organ. Unpleasantness, although it usually accompanies pain, is not identical with it. Pain may be at times pleasant as when a boy gently moves a sore tooth. In pathological cases, extreme sensory pain seems to be distinctly pleasant although it is still pain. Just as unpleasantness usually accompanies pain, it usually, but not invariably, accompanies bitter tastes, certain odors, pressures, giddiness, nausea and other experiences. In these instances the unpleasantness is clearly distinct from pain. Pleasantness similarly usually accompanies other sensory experiences such as sweet, mild sour or salt, many odors, colors, pressures and sounds. Pleasantness does not invariably go with these experiences, however. When one is satiated, sweet may be unpleasant; when one is nauseated, the odor of fruit may be unpleasant; when one is tired, otherwise pleasant voices may be displeasing. The feelings, then, while they may accompany any sensory experience are not identical with any of these here mentioned.

Theories concerning the Physical Basis of Pleasantness and Unpleasantness.—There is little information concerning the physical bases of feelings. Just what bodily organs are immediately responsible for them and in what way is not known. Since we do not know the facts, there is nothing to offer but a series of theories. Of these we shall outline briefly but one such theory.

The Theory That Feelings Are Blends of Organic Sensation-Qualities.—To account for the facts concerning pleasantness and unpleasantness which observations have revealed, it has been suggested that these two feelings are blends of sensation-qualities in the same general sense that emotions are. It is assumed that each is the result of a particular organic change set up by some stimulus. According to this theory, the stimulus, say a clash of cymbals, produces not only awareness of noise but also a certain complex organic change in the body. This organic change now arouses the receptors in the organs concerned and the nerve impulses thus actuated, on reaching the brain, arouse a complex of sensory qualities. This blend of sensations is the feeling. It is the combination of organic qualities aroused indirectly by a cycle of stimuli and responses. The feeling must necessarily lag behind the sensation but probably by an almost or quite imperceptible time. The theory, furthermore, assumes two combinations of organic changes which are antagonistic and mutually exclusive. One group of changes produces the blend of qualities termed pleasantness; the other, unpleasantness. A sweet taste usually is immediately followed by inner changes of the first sort, a bitter taste by changes of the second sort. The thought of a friendly act arouses the changes which result in pleasantness while the thought of a harsh rebuke arouses the unpleasant type. According to this type of theory, both pleasantness and unpleasantness are blends of sensation-qualities which are the result of two different forms of internal reactions.

This is a very attractive theory and one that is gaining in favor. The difficulty with the hypothesis is that we are not sure what mutually exclusive types of internal responses go with pleasantness and unpleasantness exactly and exclusively. One psychologist (Allport) has suggested that the basis of these two feelings is the same as that of the emotions. He suggests that the cranial and sacral division, or some phase of it, produces the internal changes that account for pleasantness while the opposing sympathetic system elicits the organic reactions that result in unpleasantness. This is a plausible suggestion. It would not mean that pleasantness is always the same as the emotion of the joyful type nor that unpleasantness is identical with fear, anger, or rage. It would mean merely that pleasantness is a component of the first emotions, and unpleasantness of the second. The feeling might appear as the result of very slight autonomic innervation; it might be quite swamped in the violence of a profound emotion.

The final tests of the theory are two: (1) Do we ever get pleasantness without cranial and sacral stimulation or do we ever get unpleasantness without sympathetic innervation in some degree? (2) Do we ever get pleasantness when the sympathetic is in action or do we ever get unpleasantness when the sympathetic is supplanted by the other division? We cannot at present answer these crucial questions with confidence. A final decision as to the validity of this attractive theory cannot now be rendered.

The Functions of Pleasantness and Unpleasantness.—While the physical basis of the process is unknown, pleasantness and unpleasantness are nearly universally recognized as among the fundamental native reactions of the organism. Many experiences are accompanied by pleasantness, others by unpleasantness, because of our original nature. As William James writes: "Why does a hen, for example, submit herself to the tedium of incubating such a fearfully uninteresting set of objects as a nestful of eggs? Why do men always lie down, when they can, on soft beds rather than hard floors? Why do they sit round the stove on a cold day? Why do they prefer saddle of mutton and champagne to hard-tack and ditch water? Why does a maiden interest the youth so that everything about her seems more important and significant than anything else in the world? Nothing more can be said than that these are human ways and that every creature likes his own ways."

In general, those experiences which are accompanied by pleasantness are beneficial for the organism; those which produce unpleasantness are harmful. There will be many particular exceptions; our native organization is not equipped to meet perfectly all the situations of varied lives. Much is left to learning and our native tendencies to be satisfied and annoyed are greatly modified by experience. Some things originally distasteful we learn to like; other things natively pleasant we learn to dislike. But to many situations we instinctively react in one way or the other and in the majority of cases the pleasant reactions are biologically serviceable. In this fact lies the function of the feelings.

Pleasantness and unpleasantness are each correlated with a fundamental attitude of the organism. Pleasantness goes with the positive attitude of acceptance, acquiescence or following up; unpleasantness goes with the negative attitude of recoil, rejecting or avoidance. The situation which arouses pleasantness is the one which we remain with and perhaps deal with further; the situation which produces unpleasantness we seek to avoid or escape. Pleasantness is a conscious state which stands as a sign of situations to approach and react to further, unpleasantness stands as a sign of situations with which to have no further dealing unless to avoid or remove them. The two feelings, then, are intimately linked up with two fundamental forms of bodily adjustment, positive and negative. As such they play a significant rôle in reactions in general and in the process of habit formation, as we shall see later in detail.

The full-fledged emotions may be thought of as the outcome of the most extreme forms of accepting or rejecting reactions. A full, giving way to or acceptance of a situation goes with cranial and sacral action; the most extreme negative reaction, whether it takes the form of fear and flight, or anger and attack, goes with sympathetic discharge. Thus we may think of emotions as corresponding to maximum degrees of the positive and negative reactions.

Finally, it should be noted that substantially all of the instinctive adjustments outlined in the preceding chapter may be classified into three main groups:

(1) Those which comprise acceptance, follow-up or positive adjustments.
(2) Those which comprise rejection, avoidance or negative adjustment.
(3) Those which comprise uncertainty, hesitation or exploratory adjustment.

Only the third type needs comment. If an infant is not peacefully accepting a situation or pursuing it more fully on the one hand or getting rid of, or away from it on the other, what is he doing but studying it merely to decide which of the two adjustments to take? What is the wide-eyed concentration of a child upon a new situation but a period of cautious exploration; a hesitation before acceptance and further positive action or rejection and avoidance, a mere pause before the leap or retreat?

QUESTIONS AND EXERCISES

1. Near the end of the chapter it was stated that instinctive forms of adjustment, as outlined in Chapter IV, could be grouped under three types. What are these types? Test this statement by reviewing the inventory of reactions referred to.

2. In what way are feelings and emotions related?

3. Observe an infant or a child who is experiencing some emotion. Describe the facial and bodily movements, and other "expressions." In what respects are they preparatory reactions and how do they affect the behavior of others?

4. What emotions predominate at ages, 3, 6, 10, 15, 40?

5. Can you offer any evidence in favor of the statement that grief, melancholy, anger, or fear are sometimes satisfying?

6. Is it wise to give way to an emotion when you feel the impulse? Explain.

7. How often does the average adult experience fear under the conditions of modern life? List some of the situations which provoke fear. Do the same with anger.

8. Can you think of situations, under modern conditions, wherein a strong emotion would be of utility?

9. What are some of the impulses which you have experienced when angry or frightened?

10. Were there cases in which the impulses changed while the emotion remained the same? Can you cite cases in which the emotion changed while the impulse remained the same?

11. Give samples of "irrational" fears, angers, melancholias, etc.

12. What emotions, chiefly, arise when you are physically tired, tired by mental work, hungry, or in states of illness, indigestion, uncertainty?

13. What people are, as a rule, more emotional: successful or unsuccessful, intelligent or dull, educated or uneducated? Which have the more irrational emotions? Which have the stronger emotions?

14. What account does the school take of emotional differences? What is done in the way of emotional training? At what ages should emotional habits—keeping one's temper, resisting stimuli to fear, grief, anger, etc.—be established?

15. Is there any likelihood that an average person can learn to control his emotions completely? Why are we likely to be deceived in judging emotions and impulses from facial expressions of a temporary character? Of a permanent character?

16. Have you ever observed a child or adult whose emotionality was so pronounced as to interfere with health, happiness, or work?

17. Just what is meant by "general emotionality"? Arrange ten people of your acquaintance in order from the most to the least emotional. Are there also differences in susceptibility to particular emotions?

18. Can you trace in your own experience or that of others the gradual development of *habits* of emotional expression, such as habits of "feeling blue," of being easily irritated, of persistent cheerfulness? Can you find cases of developing *habits* of "crying it out" when one is emotional?

19. What should one do when one feels like giving way to an emotional expression? Why?

20. How does the fact that children and adults are often easily upset when performing before an audience bear upon the discussions of the emotions? What emotions does an audience usually arouse?

21. Give in your own words, the substance of the James-Lange theory of emotions. Cite evidence in favor or in opposition to it. What kind of experiment can you suggest which might yield crucial evidence?

22. The following experiment will provide interesting and useful data concerning your emotional life, especially if it is done by all the members of a class, thus providing results for comparison. Every night during a week record the emotional experiences of the day. (It is better to take only one emotion such as fear or anger, for observation at a time.) Grade the intensity of the emotion from 1 (very mild) through 3 (average) to 5 (very intense). Record the situation which provoked it; the time of day; the physical condition at the time, *i.e.*, fatigue, hunger, etc.; the mental condition, *i.e.*, cheerful, worried, etc., the length of time the emotion lasted; its main characteristics as introspectively or retrospectively determined; the impulses accompanying it, *i.e.*, what you felt like doing. At the end of the week summarize the data and compare with others in the class. (The results of such a study of anger among college women will be found in an article by G. S. Gates in the *Journal of Experimental Psychology*, Aug., 1926.)

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See also references in preceding chapter.

The results of studies made upon children and adults with the photographs reproduced in the chapter will be found in an article in the *Journal of Educational Psychology*, Nov., 1923, by G. S. GATES.

CHAPTER VI

FOUNDATIONS OF MOTIVATION

The child, even in early infancy, is decidedly active at times and his activity appears to be not altogether random and indifferent but motivated and directed toward some end. Waking in his crib, the infant may begin a series of activities that are not obviously elicited entirely by external situations. Activity is often sustained for a considerable period when nothing in the child's surroundings seems to be responsible for it or sufficient to explain its unique character. We guess that the child wants food, but there was no food present to arouse the movements. Our guess is confirmed by the fact that of the various things we do or present none brings his exertions to a close except food. We must conclude that activity is sometimes initiated, directed and sustained by situations or conditions which arise within the child's organism. This, indeed, is conspicuously true, not only in childhood, but throughout life. Internal conditions are the main factors which initiate, direct and sustain our activities and strivings. Among the activities most significant to students of education are the strivings which result in learning, in the development of skills, habits of mind, habits of conduct, habits of emotional response. Our information, skill and character are in large measure developed through learning, and basal to learning are the dynamic factors which initiate and sustain action and give it direction by determining what types of activities prove to be satisfying and what ones prove to be annoying.

DEFINITION OF A MOTIVE

Any factor which initiates, directs and sustains activity we shall call a motive. To motivate activity is to arouse, sustain and direct it. Since we have defined a stimulus as anything that produces a response, a motive is always a stimulus. Many stimuli, however, do not sustain activity. A pin prick causes a reaction which promptly ends. You will note, however, that the reaction you make to a pin prick is usually a jerk or other action which removes the stimulus. The moment you jerk away, the pin no longer pricks. The pin may have broken the skin, however, and this injury is a painful stimulus which may persist. If it does, it is likely to initiate further action. It is as impulsive as it is persistent. It calls for further activity. In particular the stimulus calls for a type of further action which removes the stimulus. Now, this illustrates the main features of the kind of stimulus which we call a motive. The main facts are:

(1) The stimulus is persistent; it lasts for some time.
(2) The stimulus is annoying, uncomfortable, unpleasant; it disturbs one's complacency.
(3) The annoying stimulus initiates action which is directed to remove the stimulus.
(4) Action thus motivated tends to persist, although it may be varied in character, until the annoying stimulus is removed.

There are reasons for believing that behind all human activities of a persisting sort, behind those forms of activity which result in the acquisition of information, skills and habits of thought and conduct, we shall find motives; that is, stimuli which have some degree of persistency. Among the more important of such motives are certain annoying internal conditions that may be termed cravings, urges, wants, forms of distress. While in an adult we find numberless wants, urges, irritations, desires and purposes which constitute motives, it is possible that all of these may be traced back to a number of more fundamental or primary cravings. It will be our purpose in this chapter to see whether this is the case and if so what are the original or primary factors which initiate, sustain and direct human activity.

Characteristics of Motives and Cravings

Before undertaking the inventory of the dominant cravings, an illustration of the nature and dynamic function of a typical sample may be given.

Hunger.—The craving to secure food when hungry which has been studied in infants, adults and animals (by Wada and others) portrays the several features of a characteristic human want. First, there must be a stimulus of some sort to arouse the craving. *The craving is not a condition which appears mysteriously; it is a definite reaction produced by a stimulus.* In the case of the want for food, the stimulus is a complex of internal conditions of which one invariable symptom is a certain state of muscular activity in the upper part of the stomach. For this craving it happens that there is a particular name, hunger. Hunger, itself a response, is unpleasant and impulsive in character; it is clearly an urge satisfied by an end, namely the eating of food. When the craving comes on, the subject usually becomes restless; infants begin to squirm in their cribs, turn the face about, move the lips, and if these seeking activities are to no avail, crying may ensue. Adults engaged in sedentary work are likely to rise and move about; if asleep, they may twist and turn, often waking. Animals, which, like infants, have not acquired habits of directing their attention from the hunger urges, become restless, then actively begin to strive to secure food. If the end reaction, the eating, is long delayed the urge is accompanied by an unpleasant feeling as any man will assert when dinner is late. Animals and infants under sharp delayed hunger will become violently active. Unsatisfied cravings, then, are usually unpleasant and highly productive of action, of strivings for relief. To secure the ends to which the urge directs—the eating of food in this instance—is satisfying and the restless yearning subsides.

The Dynamic Rôle of the Craving.—While there are certain interesting facts concerning the things infants and animals instinctively do when activated by the food-seeking urge, such as the native ways of picking up, carrying to the mouth, sucking or chewing or ways of spitting or letting drool out when fed, the more important psychological factor is the craving itself and the way in which it motivates activity. Hunger is a powerful urge which persists as long as life and health. It is certainly a craving extensive in its influence on behavior and learning. That it is continually at work in the life of animals is obvious and among men, despite our efforts to reduce its effects by adopting careful and regular habits of relief, it may still influence our lives profoundly. It dictates or interferes with the daily ordering of our tasks, it may influence our choice of residence or wife, it may be a motive, subtle and unsuspected, in actions which range from the choice of newspapers to the conquest of nations. How great the ramifications, how indirect the expressions of the hunger motive has never been fully disclosed.

Cravings May Be Periodic or Persistent.—Hunger, it should be noted, tends to be periodic or recurrent; it appears and disappears. It disappears, to be sure, when one has been fully fed. It may show a periodic character without wholly disappearing when not satisfied. Careful observations have shown that it becomes more acute at more or less regular intervals. Some other urges show periodicity over a wider scale. The best illustration is the sex urge which in some animals appears only at a certain season, persists in a highly active stage for a time and then subsides entirely. At the extreme, probably, is such a craving as the "desire for approval" which substantially every one experiences all of the time, although even it may be more acute at some times than at others. Cravings or motives, then, always characterized by some degree of persistence, are usually periodic or intermittent in appearance.

To describe the same or nearly the same facts, other writers have used various terms such as *preparatory reaction, impulse, interest, desire, motive, tendency to action, drive, determining tendency.* Although we shall use mainly the terms craving, want, urge or *motive*, the others may be employed at times as essentially equivalent.

Are the Dominant Cravings Native or Acquired?—The food-seeking urge, used for the purpose of illustration, is certainly native. It is found universally and appears at birth; it could not be acquired, although all sorts of activities may be learned by means of which this craving is afforded relief. Other fairly strong urges appear, however, which at first sight seem clearly to be acquired. Consider a man who has become accustomed to smoking a cigar after dinner. When the meal is over, the urge to smoke becomes active. It is a persisting, annoying stimulus. If the supply of cigars is unexpectedly exhausted, the annoyance of deprivation is usually evident. The craving may become very strong. The victim becoming increasingly restless may at length jam on his hat to walk several blocks to the store in order, as we may say, to "satisfy his habit." So with other types of acquired activities—the paper at breakfast, the afternoon nap, tea or tennis, the Saturday night trip to the movies—once they are habituated, the proper setting arouses the urge. Smoking or reading the newspaper is obviously acquired. Hence it would seem necessary to admit that many urges are learned. Some students, however—notably McDougall—are unwilling to make this blunt admission. True, they may agree that smoking is acquired and that it embraces a craving, but they insist on a deeper inquiry. How happened it that the man began to smoke? And when the answer is determined, they believe it will be found that the habit was initiated and sustained because it satisfied some other native craving. All habits, in a phrase, are born of instinctive cravings and live as their servants.

Before this view can be adequately appraised the main human cravings must be marshalled before us. But as this is being done, we shall encounter difficulties in deciding whether some are native and primary, or secondary and acquired. Such cravings, as those for a smoke or for a game of bridge, we shall disregard—they are not primary and not nearly universal in the human species. We shall confine ourselves to those that seem to be universal; those that prevail everywhere. Universality is not, however, conclusive evidence of nativeness. In some instances it will be impossible to tell whether the urge is native and primary or not. Merely to know that certain traits are universal characteristics of humanity, however, is in itself interesting and practically important in connection with motivation. In the list to be presented shortly, a number of cravings generally believed to be at least universal, and by many, both universal and instinctive, will be presented with comments as to the likelihood that the trait possesses one or both characteristics.

CRAVINGS RESULTING FROM ORGANIC CONDITIONS

In the first group are a number of urges which are primarily aroused by organic conditions. Some are not aroused exclusively by inner conditions since external situations also exert more or less influence. Hunger, for example, primarily a response to organic conditions, is intensified by the sight and smell of food and reduced by unpleasant visions and odors. It is, however, difficult to activate real hunger except when a certain organic condition prevails in some degree. Usually such an inner state is the primary stimulus to which the urge is a response.

The main cravings of this type must be described in a phrase, since for some of them we have no individual names:

(1) Hunger: the craving for food when hungry.
(2) Thirst: the craving for drink when thirsty.
(3) The craving for air when breathing is difficult or air inadequate.
(4) The craving for rest when fatigued or sick.
(5) The craving for sleep when drowsy.
(6) The craving for warmth when cold.
(7) The craving for coolness when overheated.
(8) The craving for action when well and rested.
(9) The cravings of sex when sexually aroused.
(10) The urge to escape when frightened or injured.
(11) The urge to get rid of painful and disagreeable substances or conditions.

Relative Strengths of the Several Organic Cravings.—To appraise the several organic urges in terms of their insistence when unsatisfied, in terms of the rôles which they play in habit formation or in terms of the good or evil, individual and social, resulting from such adjustments is a difficult task. While admitting that the sex impulses possess great strength and importance, psychologists are generally of the opinion that certain persons like Freud and his followers have given it an exaggerated potency. While the origin of life depends upon sex impulses, life itself is more than sex. Hunger, thirst and impulses to secure air and warmth are, so far as living is concerned, equally insistent and probably equally influential in determining the course of life's endeavors. Recent experimental investigations of the relative strengths of different urges in animals (by Moss, Simmons and Tsai) at least, show the urge of hunger to be a more powerful motive than the urge of sex. Among human beings, marital relationship is broader then sex; there are problems of food and shelter, activity and rest, sympathy and parental labors, that require adjustment and may result in compatibility or lack of it. That thwarting of the sex impulse appears to be so conspicuous a source of difficulty in civilized life is the result, not solely of the strength of these drives, but partly of the frequency with which they are aroused only to be inhibited. Delayed marriage together with the insinuations of shame and indecency and social taboos provide the soil in which perverted and distorted habits of body and mind may grow from entirely decent but persistent impulses. Better understanding and better management is required for the mating impulses which are in themselves but one of many native drives, and no more shameful, no more insistent and probably no more powerful than others.

The Importance of the Organic Urges.—That these organic cravings are native in man is almost unanimously agreed by competent students. There is a consensus of opinion, too, that such cravings are potent sources of human strivings. Men will go to great extremes to satisfy the urges of hunger, thirst, sex and other organic needs. Under acute heat, suffocation or thirst activities for relief may attain the level of violence. The traveler lost in the snow or the unrelieved soldier may give way to the impulse to sleep even if death is the probable result. The sex impulse, fully activated, may overcome ideals of propriety and the fears of disgrace or punishment. According to the views of some, the main goal of human conduct to which our innate urges impel us is the attainment of a condition of organic comfort and the avoidance of organic distress. To some who hold this view, many or all of our daily endeavors, our intellectual, athletic, avocational and vocational pursuits, are conceived of as strivings to achieve these ends. Our multiform activities, personal and social, are initiated and sustained in the service of our organic cravings.

Like the animals, among which these motives are more obviously paramount, men in general do not necessarily realize—indeed, probably rarely do understand—the forces which determine their conduct. As the influences which determine the distribution and control of the circulation of the blood are ascertained only by dint of extensive research, so the factors which occasion and control human conduct in everyday life are disclosed only by diligent and skilled study. If the statement, then, that human activities are primarily, or even extensively enlisted in the services of organic welfare is a surprise to the average man and appears to be rather uncomplimentary to him, it need not on that account be incorrect.

Summary.—There can be no doubt on several points. First, that many impulses and cravings are based upon native organic reactions; second, that such urges and efforts are important springs of human activity in the everyday life of both adults and children, and third, that innumerable habits based upon these drives are formed—habits of which the initiating and sustaining forces may not be recognized by the one who possesses them.

The view that the organic cravings are the sole or even the main springs of human action is a problem to which consideration should now be given.

Other Strong Motives

The illustrious William James, about 1890, stated that a human being inherits a large number of instincts, that is, unlearned modes of response, and that every instinct is the equivalent of a fundamental and insistent urge or impulse. His view was that certain situations would produce what has since been called a ''preparatory response'' or ''condition of readiness'' in the organs involved in an instinctive reaction. The ''ready,'' ''prepared,'' or partially active state is the source of the impulse or craving and therefore a motive. Being in a condition ready to sneeze, grasp an object or what not, one finds oneself strongly motivated to complete or ''consummate'' the full response. ''Consummating'' the response really means removing the stimulus. If the sneeze for example, is held up, the stimulus may persist and the impulse becomes intense. The motive persists until it is relieved; that is until the stimulus is removed or sidetracked by some other more intense craving. In all respects, then, the impulse or motive in the case of an instinctive reaction is comparable to hunger. The impulse, itself a response, is a stimulus which persists until removed. Such persisting impulses satisfy the definition of a motive as stated earlier.

Since 1890, studies of the development of behavior in children have shown that many forms of response, believed by James to be largely the results of the inner growth of stimulus-response mechanisms, are really largely acquired. Instincts appear to be fewer in number and less definite in organization than was then assumed. As was pointed out in Chapter IV, relatively few complex forms of overt behavior are entirely native. Many of the instincts enumerated by James may be largely acquired. The main question now debated is to what extent various forms of behavior which appear universally in human beings represent the outgrowth of native forms of response and which are entirely acquired as the result of common forms of experience and training. The best way to approach the problem is to consider the case of each of several forms of behavior concerning which opinions differ.

In taking up several of the forms of behavior which are found almost universally in human beings, we should realize that we are grouping together a number of particular reactions and not dealing with specific acts. Such a grouping is made for convenience. In each group will be included many reactions which have some characteristics in common. This common characteristic, for convenience, may be described by a name or phrase. The characteristic features under which we shall classify groups of reactions will be the "common" impulse, craving or urge. A representative but not an exhaustive list of such urges follows:

(1) The craving to acquire, collect and hoard.
(2) The craving to excel and succeed—the "mastery impulse."
(3) The urge to fight persistent interference.

(4) The urge to fight for its own sake—pugnacious impulse.
(5) The urge to be submissive.
(6) The craving to secure sympathy.
(7) The urge to hunt and destroy.
(8) The urge to relieve suffering—"impulse of sympathy."
(9) The urge to care for and protect children—"parental impulse."
(10) The craving for companionship—"gregarious impulse."
(11) The craving for social approval.

The Craving to Acquire.—The child tends to approach objects which attract his attention, pick them up and cling to them. Often he carries them away to some place of storage. By some it is believed that this tendency to acquire or even to collect and hoard is instinctive and primary. It is believed that, in the presence of such objects, urges to seize and accumulate are aroused as instinctively as in the squirrel, and that to carry out such acts is gratifying like the appeasing of hunger. Quite apart from the value the objects collected may have as food or implements and the like, there is satisfaction in consummating the mere urge to acquire things once it is aroused.

In our survey of instinctive reactions in the preceding chapter we found that the infant very early reaches for and grasps various kinds of objects which are carried to the mouth or variously manipulated. The Gesell behavior schedule shows a progressive series of elaborations, refinements and extensions of these grasping reactions. We found reason to believe that starting in simple and crude acts, the acquisitive reactions develop as a joint product of heredity and experience. If an infant shows grasping reactions from the first, and continues vigorously to extend his acquisitive abilities best to suit his conquest of his particular environment, are we likely to be misleading if we say that a human being is a grasping, acquisitive person from the beginning? That is what we mean when we say he possesses native tendencies to acquire.

According to this view, the urge to collect and hoard in a world of attractive objects becomes constantly aroused. The child collects at first bits of colored twine or paper, cigar bands, stamps, pictures, trinkets of all sorts; as an adult he may collect other things—rugs, hunting implements or books—but the same sort of urge is present and the same sort of satisfaction in getting and keeping is secured. Man, then, according to this view may be described as instinctively an acquisitive animal; the urge merely to have and hold characterizes his life.

The Urge to Excel and Succeed—the Mastery Impulses.—The urge to excel and succeed may be subdivided into several, such as the urge to overcome opposition, to resist domination by other persons, to dominate or master things, to dominate other people, to excel a rival and to achieve success in undertakings. Each phase of the urge merits brief description.

The Urge to Overcome Opposition and Obstruction.—It is characteristic of children and adults to desire to go about their business without interference. Any kind of obstruction tends to arouse vigorous activity directed toward the removal of the obstacle. This is apparent soon after birth. A newborn infant can be enraged by interfering with his movements. A child's toy which will not work, a door which will not open, a block of wood which will not split, a thicket which will not permit passage—all such impediments provoke impulses and acts to overcome them. So commands and restrictions, in so far as they interfere with activities under way, tend to arouse resistance.

The tendency to overcome obstructions and interference was shown in an interesting way in a laboratory experiment (by Morgan) in which a subject engaged in the task of typewriting was subjected to a number of distractions, such as the sounds of buzzers and bells, or sudden changes in illumination. He was at once aroused to overcome such interferences. His pulse ran up, his brow was wrinkled, teeth were clenched, the keys were pounded harder than usual, and in most instances the typing was kept up to the average, although more energy than usual was consumed.

The Urge to Dominate People and Things.—The child not only resists interference and domination but he also likes his blocks to stay put, his horn to blow, his dog to come when called, his playmates to follow orders. Even in infancy, a child may cry in rage when mechanical objects won't do what is wanted. He likes to have his projects, whatever they may be, go through to a completion successfully. To succeed in any undertaking is intrinsically satisfying. This phase of the urge to succeed is often called the "mastery impulse." Adults show evidence of this urge in innumerable directions. To climb an imposing tree or chop one down, to breast a strong current, to "break" a spirited horse, to ascend a steep hill "on high," to lift a huge weight, to down a worthy opponent in wrestling, to solve a knotty problem, to swing a big deal or boss a crew of men, are particular ways in which the urge may find gratification.

The Urge to Excel a Rival.—A keenly satisfying form of behavior consists in the excelling of a rival. Man keenly loves competition. The gratification of outdoing a competitor is one of the mainsprings of interest in games and sports of all sorts—chess, bridge, tag, baseball, tennis. This urge operates from early childhood to the end of life. It takes uncounted forms; in practically any activity, the presence of another who may be taken (even if he is unaware of it) as a competitor adds zest to the work and elicits greater efforts from the worker. How effective the urge is when activated in this way will be disclosed in some detail later.

The Urge to Succeed, in General.—The craving for success, in all of its manifold forms, is one of the most interesting and important human urges. However humble or trivial the activity may be, if one is demonstrably a success—that is, if he can overcome the difficulties in the task, can master the situation and excel his accepted rivals—one of the keenest human gratifications is realized. These facts appeared interestingly in a study (by Meek) of the first efforts of children, three to five years of age, to learn to identify certain printed words. Some succeeded quickly in mastering the first lesson but a few failed completely. Those who succeeded came back to the lesson happily on the second day. Those who failed were less eager, and after a few further failures were exceedingly reluctant, sometimes testifying to other more important engagements or hiding behind the piano. They hated this task which brought them failure even when they were praised for their efforts or otherwise rewarded. Some who were coaxed back, were skillfully shown how to attack the learning of the words. They succeeded. Next day, success again; and soon an entirely new attitude, a happy and eager interest in the learning tasks. Nothing makes functioning more satisfying than success; nothing stimulates further efforts to achieve like success. We do not like difficulties except as they provide opportunities for success. What we crave is to overcome difficulties successfully.

Fighting to Overcome Interference.—The tendency to overcome obstructions to, or interference with, an activity under way is a close kin of the impulse to seek domination actively, and both are related to fighting. Think of a boy building a playhouse. If all goes well, each nail driven and each board affixed satisfies his impulse of mastery, and the thought of the completed house is a stimulus to his self-assertion. Let some of the boards split or some of the nails bend, and the boy is aroused to overcome these obstructions to progress. If things go from bad to worse, swelling rage may lead to a fighting attack in which the structure is utterly demolished. Or, with things going well enough, if another boy interferes by word or deed, disregarding commands to desist, he may be the object of attack. *The stimulus in fighting is an interference with an activity under way.* The pugnacious attack is simply the most violent form of the effort to overcome an obstruction in the path of one's action, and inasmuch as it is the last resort, it is a less frequent reaction. Fighting in such instances is not primary and its own sufficient reward; it is a means to an end. The removal of the obstacle or the successful issue of the combat, rather than the combat itself is gratifying.

The Alleged Urge to Fight for Its Own Sake.—By some it has been maintained that there is an urge to fight quite irrespective of the provocation or the outcome; a craving to engage in battle just for the satisfaction of combat. An investigator who followed the activities of boys' gangs found among these healthy and vigorous youths very frequent individual, "free for all" and inter-gang combats. The zest for battle appeared so keen that some have been led to believe that it was primary and irreducible to other urges. It was a zest for combat sure and simple. It is said, furthermore, that this impulse persists into adult life despite efforts to curb its expression. Most of us, it is said, liking battle but having an eye to propriety of conduct, and also to the danger of injury, get our thrills by reading about or observing others fight—a single prize fight drew gate receipts of nearly two and a half million dollars—or instead of fighting with tooth and fist, we learn to attack with cutting remarks, piercing looks or annihilating thoughts only. We are, it is said, fundamentally pugnacious and to a degree feel the craving to fight.

It is not conceded by all authorities that this type of fighting urge—the mere craving for combat—is a universal human characteristic; much less that it is native or primary. It is maintained by some, for example, that fighting is always done to secure mastery or social approval or, under primitive conditions, to secure food, shelter, mates or some other reward. The "pugnacious mood" is also explained as fundamentally depending on some interfering or disturbing factor, such as bodily discomfort or irritation—fatigue or indigestion—or upon thwarted cravings of some sort. Thus fighting is conceived as a secondary means to some end, to the attainment of satisfaction for some other urge, rather than as due to a specific craving for combat. This view seems in the light of recent observations to be the correct one.

The Urge to Hunt and Destroy.—The desire to hunt is sometimes included among the primary cravings. It is alleged that children at a certain age experience impulses to chase and capture small animals much as the kittens are observed to do. Later, as such reactions are killed off by training, it is alleged that the hunting impulses secure gratification in the teasing and hounding of eccentric characters, unpopular leaders, or minority groups such as pacifists, atheists, etc., or in running to earth and destroying wild game, or even human beings as in the hastily conceived mobs or lynching parties. While such unreasoned brutality doubtless is prevalent among mankind, it may be accounted for in terms of other cravings and hence considered secondary. The early "hunting" of the child may be an expression of the food-seeking or collecting impulses or mere curiosity; the bullying of adults may be accounted for in terms of impulses to secure the mastery, to dominate and victoriously engage in combat. The hunting of game, widely enjoyed by men, may be similarly explained—food getting, collecting, mastery and successful combat are served at once. Hunting, then, is probably not specific and independent of other impulses. Although secondary and derived, the zest for teasing, harassing, plundering, attacking and damaging is doubtless nearly universal in mankind.

The Urge to Submit.—Submission is the antithesis of the tendencies to overcome opposition, to secure mastery and to fight. Forced submission to an obstinate obstruction or to a superior opponent or in the event that escape is cut off during fear is frequent enough, but it is not a source of satisfaction. It is characterized by such behavior as weeping, anger, chagrin, envy, jealousy, shame or embarrassment. Frequently, however, there appears an impulse to submit when submission seems to be gratifying. The situation which provokes submission is one which obviously cannot be mastered. Thus the child may be submissive to the adult, the adult to a wiser or more influential person, or to society as a whole. Admiration, awe, reverence, veneration, "hero worship" and love are indicative of willing submission. Universal tendencies to be awed by, as well as to venerate and idolize unusual, unintelligible or powerful natural phenomena, such as winds, thunder or the sun, perhaps are rooted in an urge to be submissive as well as in fear. We seem, then, to desire to have, as well as to be, a master. These two impulses are not inconsistent but reciprocal. In submission, one is unaggressive, deferential and admiring. This behavior may be satisfying when the attitude of the superior toward us is appreciative, kindly or generous, even if dignified and condescending.

The Craving for Sympathy.—The impulse to be submissive is closely related to the craving for sympathy. When submissive, we expect kindly and sympathetic mastery. Sympathy the human species universally craves. To secure consolation the child eagerly displays his injury; or as has sometimes been observed, inflicts a cut or bruise in order to reap abundant pity. For the same purpose, adults are disposed to show their bruises, relate their accidents, illnesses—especially the details of surgical operations—hardships and misfortunes. Some become chronically addicted to tales of woe as a means of securing bounteous sympathy. "Self-pity" for misfortunes, real or imaginary, is in some measure practically a universal practice. To secure sympathy is clearly a strong and essentially universal human urge. It is doubtless one of the impulses involved in many instances of submissive behavior but probably does not fully account for all forms of submission.

The Urge to Relieve Suffering—the "Impulse of Sympathy."—While the urge to secure sympathy is strong and clear, the urge to express compassion by active efforts to relieve misfortune and suffering has not always been quite so apparent, at least not apparently primary and fundamental, in the human species. Yet sympathetic behavior of some sort is characteristic of most animals.

Plaintive cries of distress and other evidences of suffering usually arouse in the human being an urge to relieve the sufferer. The prevalence of societies for the prevention of cruelty to animals, of child labor, for the relief of distress in foreign lands; public institutions for the poor, homeless, blind, feeble-minded and other types of good will are evidences of a widespread urgent compassion. At the same time it is necessary to explain the extensive brutality exercised by man upon other men and animals with which history is replete. The explanation is that mankind is at once sympathetic and self-seeking. The urge to relieve suffering, we believe, is genuine, but, living in competition with the urge to secure food, achieve success and mastery, collect and hoard, etc., it is often submerged. For social welfare, the sympathetic tendencies, obscure as they often seem, are of prime import. Because they are often overthrown by antagonistic urges, the home, school and church do and must join forces in encouraging and rewarding the sympathetic dispositions as a means of promoting the ideal social life, conceived by human intelligence but with difficulty achieved in human behavior.

Urges to Care for Children—the Parental Urges.— Among competent students there is nearly unanimous agreement that the infant is a potent source of urges which are satisfied only by evidences of its comfort and well-being. The urge to care for and to protect valiantly their young offspring is strikingly apparent in many animal as well as human parents. Mothers, human or animal, seem especially responsive for a time after birth perhaps as a result of their organic condition. It is unlikely, however, as suggested in the preceding chapter, that human parents have inherited motor activities of caring for the infant in forms approximating the elaborate, and apparently, instinctive behavior of many lower animals.

The Craving for Companionship—the Gregarious Impulse.—Gregarious animals, buffaloes, sheep and wolves, are those which live in herds or flocks. Others, such as cats, tigers and lions, are solitary beasts. Given the same opportunities to live together, they prefer solitude. The human species is essentially gregarious; the seclusive individual, rarely found, is regarded as abnormal. For these reasons, it has been usual to assume that gregariousness in man is a fundamental instinctive urge—a conclusion not universally accepted.

Strictly speaking, gregariousness is merely an impulse to be with other people. We feel more comfortable under most circumstances when with companions; rarely does one choose to live in entire isolation. When quite alone we become uneasy and lonesome; solitary confinement is a torturous punishment which usually brings confession or breakdown. No one of repute questions the existence of the gregarious impulse, but several deny it a specifically instinctive character. They argue that it is acquired. Having lived with people from the first, we become "used to" them. When they are gone we feel at a loss much as we feel the loss of a pipe, a friendly chair or as we may feel an uncomfortable lonesomeness after leaving the familiar surroundings of home. More than that, from childhood others of our species have given us aids and comforts of innumerable sorts; we like to be with others because we have learned that they add to our security and comfort; they enable us, moreover, to satisfy our submissive, mastery, parental, mating and other impulses. Any one of these conditions, it is asserted, is sufficient explanation of the gregarious impulses. The gregarious urge at least is strong and essentially universal in man but rooted in a complex of other instincts and early experiences.

The Craving for Social Approval.—The impulse to secure social approval goes beyond the mere satisfaction of being in a group. The approving words, glances, smiles or attitudes of other people are among the keenest sources of satisfaction. In numberless direct or subtle ways we seek approval; the child, by displaying his repertoire of tricks; the youth, his strength, daring and skill; the adult, by means of personal appearance, clothes, relatives, social connections, wealth, achievement in business, politics, society, athletics, philanthropy, or by wit, generosity, aloofness and in other ways too diverse to recount. Lacking superiority in skill or valor, social virtues, personal appearance or intellectual accomplishment, one may resort to fine manners, fine talk, extravagance, boasting or arrogance.

The Urge to Avoid Social Disapproval.—As approval is a keen satisfier, so social disapproval may make life intolerable. Our sensitivity to facial blemishes or bodily disfigurement, the misery occasioned by a social blunder or a public criticism, are as intense as they are irrational. We are disturbed even if a dog or a tramp acts disapprovingly. A Zurich psychiatrist, Adler, has developed a conviction that many nervous and mental disorders are the results of the continuous disapproval which physical defects or deficiencies may bring.

In many instances, the urges to secure social approval and avoid scorn are similar to the impulses to secure mastery and avoid domination. Both may, in fact, be operating at the same time, but there is a difference between them. One may check his self-assertive tendency to a point of submission or humility in order to be considered ‘‘nice,’’ although here the desire for social approval is conceivably the mastering impulse in disguise. On the other hand—and here the distinction is clearer—a man may dominate his wife and family or his employees or debtors so severely as to bring the disapproval of all who observe, yet the hard master may enjoy the rôle. In the case of bullies on the school ground or elsewhere, the craving for mastery may run counter to the impulse to secure social approval.

Instincts and Habits

Whether or not the urges here listed are native and primary, they must be considered important. They are significant because they are practically universal and very strong. Whether our guesses concerning the sources of the newborn infant's reactions are correct or not is largely of academic rather than of practical interest. Under present conditions these cravings certainly tend to appear. They would—in fact they do—appear under very different forms of early education. They usually become thoroughly established early in life. Whether they are native or early acquired matters little, practically, for the reason that firmly established habits and instincts, after all, function much the same.

A strongly established habit is indistinguishable on any score except in degree of tenacity from an instinctive response. Both are based on neural connections; whether inborn or acquired matters little, as far as we know, as long as the connections are equally firmly established. A strong habit is quite as insistent, quite as truly a basis of motivation, as an instinct. To illustrate: we do not know, for certain, whether left-handedness is due to innate growth of neural connections or to connections established by early experience. Even if we did, we would be in no better position to decide whether we should teach a left-handed child to write with his right hand. We would have to conduct investigations to find out. We know that by six years of age the habit of using the left hand is strongly fixed in some children and the urge to use it is strong. We believe that changing from one hand to the other can be done without harm provided we use admirable methods of effecting the shift. We know, moreover, that the use of crude methods of making the change will sometimes produce serious disturbance. It is a problem of method rather than a question of whether we are in such cases "going against nature" or going against a firm habit.

Habits and instincts, then, differ in the mode or origin rather than in character, potency or significance. Whatever the source of the strong urges, described in this chapter, turns out to be, the impulses themselves will be important motives to take into account in the process of education.

USE OF STRONG URGES IN MOTIVATING ACTIVITY

Now that many of the most important and prevalent human motives have been surveyed, it is time to show how potent they are in motivating behavior. In the remainder of this chapter we shall consider briefly certain of the "social" motives and show how much and in what way they influence typical school activities and learning. In the next chapter we shall consider the potency and diverse ways in which they condition and direct other phases of conduct.

Motivation during Short Periods.—The potency of certain motives in influencing achievement is illustrated in pronounced form by an experiment upon college students (by Knight and Remmers). Ten college freshmen, after being subjected for five days to severe humiliation, hard work, loss of sleep, hazing and general torment, were given, late at night, a series of tests in computation, the results of which, the freshmen were convinced, would have considerable weight in deciding their fitness for admission to a college fraternity. The motivating factor was in particular their desire to qualify for membership, and, more broadly considered, the desire to secure social approval. Seven five-minute tests were given with but short intervals between them. The results of these tests were compared with those obtained from fifty college juniors whose work was not motivated in any special way. As regards intelligence, age and arithmetical ability, it may be assumed that the juniors were at least as good as the freshmen; as regards physical fitness the juniors certainly possessed a striking advantage. The juniors, however, during the seven five-minute periods averaged 9.6 problems correctly solved per period, whereas the tired freshmen during their first seven tests averaged 18.3 problems per period, or twice as many. Since in every other respect the juniors had the advantage, the differences in achievement must be credited to the factor of motivation—to the urge to secure social recognition and approval.

Motivation over Longer Periods.—That the influence of motivation is not necessarily limited to a temporary spurt, and that it results in stable improvement when so utilized as to affect practice has been disclosed by several studies. In one of these (Kitson) the daily output of forty hand compositors in a Chicago printing establishment was followed for a year during which motivation was provided by giving a cash bonus for increased productivity and by the recording and display of evidence of improvement. These men were mainly experienced workers with periods of service in the trade from 2 to 27 years, and an average of 10.3 years. Many had been working on a dead level of efficiency for years. Under the influence of these incentives, the men, young and old, began to improve. After five months their output was 67 per cent greater. Since these men were more experienced and therefore presumably more fixed in their habits, they improved less on the whole than the less experienced men. There were some striking exceptions, however. One man who had been in the trade for 27 years increased his output 142 per cent.

The Influence of Displaying Results of Achievement.—The mere display of the achievements at the end

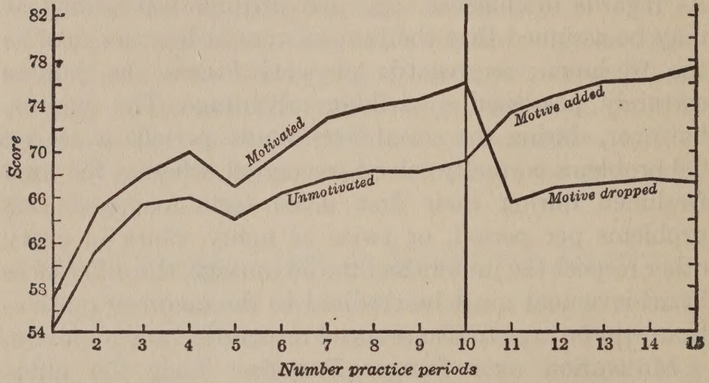

FIG. 20.—SHOWING THE INFLUENCE OF DISCLOSING EACH DAY TO THE SUBJECTS THE SCORES MADE IN THE PRACTICE PERIOD. The task was the writing of as many legible "a's" as possible during a 30 second period. During the first ten practice periods, the group thus motivated made greater improvement than the group which did not learn the results of its work—the unmotivated group. From the tenth day, the motivation was reversed. The first group, now not permitted to see their progress, begin at once to lose, whereas the other group, on studying their scores, progresses rapidly. (Modified from W. F. Book, *Pedagogical Seminary*, Dec., 1922.)

of each practice period arouses a very potent urge to improve. The display of results gives definiteness to the urge to succeed, to overcome resistance. The urge to surpass others is also enlisted. Rivalry produced by the sight and sound of others working and especially by the awareness of the achievements and gains made by others as well as by one's self is definitely involved. Several investigators have found that children work better and faster and improve more rapidly when working together under the spur of competition than when working alone. The circumstances surrounding a "test" in the classroom or the psychological laboratory usually spur the subject to greater effort than under ordinary circumstances. The presence of the experimenter looking on and the presence of other subjects taking the test at the same time seem to produce greater effort than is secured when the subject works alone. Figure 20 shows the results of an experiment in which the public display of results was the means of enlisting some of these social urges. The influence was very marked.

The Influence of a Discussion Group.—In another study (by G. B. Watson) college students of education were given tasks which required thinking and imagining. In one case they worked alone and in the other they worked in a small discussion group. It was found that the typical student's thinking and creative imagination were more productive when carried on in the give-and-take of the discussion group than when he worked by himself. The presence and activities of his peers seemed to act as productive stimuli. They increased mental alertness and creativeness.

The Influence of Approving and Disapproving Remarks.—It is usually found that school children, gathered in a group for a test by a strange examiner, are highly motivated. The motives are several; one of them surely is the desire to secure approval and to avoid scorn. Suppose that even when motivated by such test conditions, several groups of children who really have done equally well on a first test are given different treatment. One group is called together and told that every one did splendidly on the test; a second group—which really did equally well—is told that every one did poorly and is severely chided for inferiority and carelessness; a third group of the same ability as the other two, listens in on the remarks made to the other groups but receives no comments upon their own work; a fourth group is separated entirely from the first three and receives no comments. One investigator (Hurlock) tried out such a study with school pupils. She repeated the program on five consecutive days. The tests consisted of a series of arithmetic problems. Figure 21 tells the story in graphic form.

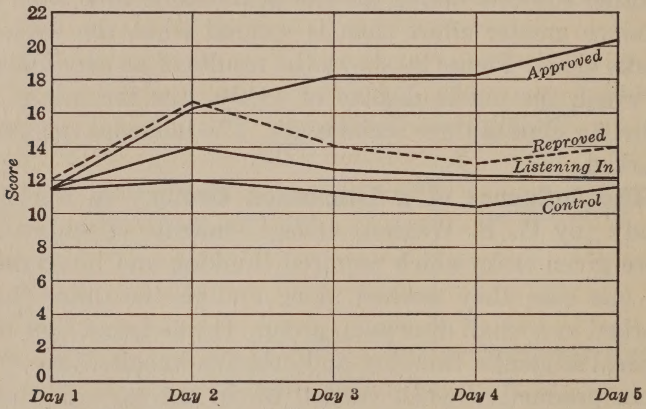

FIG. 21.—THE INFLUENCE OF APPROVAL, DISAPPROVAL AND "LISTENING IN" ON THE APPROVAL OR DISAPPROVAL OF OTHERS. See text for discussion. (After Hurlock.)

In Figure 21, the curve for the fourth or "Control Group" indicates that no improvement was made during the five days when no special motive was used. It shows that group 3, the "Listening In Group," was stirred up at first so that it did better on the second day but that, having received neither praise, scorn nor any other recognition, it began thereafter to slump toward the level of those who received no special motive, *i.e.*, Group 4. Group 2, which was reproved, shows a tremendous gain at first, but the effects of continual disapproval were less persistent than those of praise. The approved group (Group 1) comes out at the end with a score nearly twice as high as that of the Control Group (Group 4) which was composed of equally able children.

Individual Differences.—This study is reported to show how pronounced the influence of such social motives are and not as a suggestion that every pupil be praised for everything all of the time. Effective motivation is a complicated problem. One can overdo praise and apply it unwisely. Individual differences in reactions to such incentives must also be noted. In this study some profited more by reproof than by praise; some were unduly overstimulated by either. Indeed, in all of the studies of motivation, wide individual variations are found. Some persons require very little special motivation to put forth their best efforts; others require considerable. Some are very stable in performance under extreme effort whereas others, when strongly motivated, show a decrease in efficiency, become confused or "go all to pieces." Some are disturbed by factors which merely stimulate others to an optimum. All of these variations indicate that such incentives are extremely powerful influences although their effects may vary with individuals. As we shall see later, they affect performance, on the whole, more than substantial doses of such powerful drugs as caffeine (in coffee or tea), nicotine (in tobacco), alcohol or the products of extreme fatigue. The fact that they are so potent means that such incentives should be employed with great care and sagacity.

PURPOSES AND PURPOSIVE BEHAVIOR

We have defined a motive as a recurring or continuous stimulus. A motive is distinguished from other stimuli merely by being relatively persisting. An itch, which is the response to a skin stimulus of some sort, and hunger, which is a response to internal stimuli, are called motives because they tend to persist and also to initiate and sustain activity until the itch or hunger is removed or appeased. Whatever the stimulus which arouses the motive may be, the motive itself is a persisting activity or condition in the organism which it moves to further activity.

Motives Differ in Desirability.—We have seen, furthermore, that probably in the initial stages, as in earliest infancy, all motives are based in vital organic cravings and in fundamental instinctive reactions of acceptance and avoidance. Under typical conditions there develop from these seeds a number of cravings so prominent and universal as to be safely considered, for practical purposes, as dominant urges, like the urge to secure social approval or to master obstacles. When, by the use of appropriate stimuli such as the posting of scores obtained in a series of tests, one or more of these urges is aroused vigorously and permitted to express itself by high achievement in a given task, we see that the motivation is very potent. From the viewpoint of education, we aspire to a form of motivation, however, that is less artificial, less unrelated to the work itself, less dependent upon classroom management by the teacher. We aspire to higher motives. In particular, we desire to have learning and behavior motivated by *ideals and purposes;* we wish behavior to be *purposive.*

Definition of an Ideal or Purpose.—What are ideals and purposes? To begin with, an ideal or purpose, as it is usually understood, has the character of a motive. It has stability and persistence; it can initiate, sustain and guide action. It is "an activity leading to further activity." Thus it satisfies our definition of a motive.

Ideals and Purposes as Motives.—An ideal or purpose is represented, too, by an activity or condition in the organism. It is, furthermore, something acquired. Although it grows out of experience, it is not utterly unrelated to the dominant urges listed in this chapter. An ideal or purpose, in fact, is a motive developed by the use of such cravings. An ideal or purpose is the product of learning in which the organism is capable of some foresight of an end or goal which it strongly craves to achieve. My ideal or purpose may be to become the best burglar or the most zealous patriot, to accumulate a fortune or to dissipate one. The essence of the ideal or purpose is that it involves an end that can be conceived, thought of or foreseen, at least in a general way, and a persistent urge to achieve that end. It is, in a phrase, a motive that is directed consciously toward some goal. A purpose, or ideal, then, fits nicely into the stimulus-response psychology. A purpose is an inner response aroused by a stimulus just as the contracting action of the stomach walls is an inner response produced by a stimulus. A purpose is persistent like hunger. It is a motive like hunger. Both are cases of "an activity leading to further activity." There is no need to make ideals or purposes occult entities as many educators and some psychologists seem to do.

There are a few further facts to note about ideals and purposes. The first is that they are two names for the same facts. Both refer to internal factors that initiate and sustain action; both are persistent inner stimuli; both represent a departure from purely instinctive or primary urges as the result of learning. An ideal or purpose is the outcome of education and experience. Under undirected experience ideals and purposes tend to be conspicuously primitive and selfish; by means of education we hope to foster ideals and purposes which advance the welfare of mankind as a whole. The educational process by which such ideals and purposes are acquired is concerned with the development of information, conduct, habits and technical skills, An ideal or purpose of a desirable type is by definition, a sort of ultimate educational achievement. It embraces foresight of desirable ends, desire to achieve the goals, knowledge of the means essential to attainment of the ends and satisfaction at each step taken toward the ends. To treat fully the development of purposes and ideals, then, will require many subsequent chapters.

QUESTIONS AND EXERCISES

1. Define a motive. Which of the following could satisfy the definition: a. a tickle in the throat; b. the idea of becoming a fine singer; c. a toothache; d. the habit of sleeping after a meal; e. the desire to do and say funny things.

2. Consider the tendency to collect objects. When does it first appear? When is it strongest? When, if ever, does it die out? How does it change, if any, during life? Is the tendency native or acquired?

3. There have been various doctrines based on the assumption that "nature is right, there can be no higher criterion." It is asserted therefore that children should be permitted to develop without inhibition, that they should be permitted to do whatever is "natural" for them to do, on the assumption that nature is infallible, that no instinctive trends can be undesirable. In the light of available facts, how valid is this doctrine?

4. Is it reasonable to suppose that there may be urges and instincts, useful ten thousand years ago, that are not useful now?

5. What is the significance of this statement from William James: "Man has a far greater variety of impulses than any living animal; and any one of these impulses, taken in itself, is as blind as the lowest instinct can be; but, owing to man's memory, power of reflection, and power of inference, they come each one to be felt by him with a foresight of those results." Does James mean that man arrives eventually at a full understanding of the impulses which initiate his activity?

6. Which of the urges listed in the chapter do you experience most frequently during the day? Which least frequently?

7. Is the fighting urge as strong in women as in men? How would you go about discovering the facts by scientific investigation?

8. Is *play* an instinct? Is it universal? Could play be considered as the result of the operation of the urges listed in the text rather than as a new instinct? Make a list of various forms of play among children or adults and analyze representative forms into the impulses operating. Is there anything left unaccounted for?

9. Why do people like to tease? Why do boys like to break windows, steal apples, torment peddlers, etc.? Is there a sex difference in the urges behind these acts?

10. If there is a strong urge to collect and hoard, why do so few people accumulate sufficient wealth to support themselves in old age? Name other urges which are antagonistic to collecting and hoarding.

11. What are the main impulses involved in adornment? Is it a specific urge? Would a person living alone adorn himself much? Do men or women give more attention to adornments? Explain.

12. Which of the urges listed in the chapter are most prominent? Which ones persist through adult life? Which ones become stronger in adult life? Which ones are taken into account by religious doctrines or public laws?

13. Name a dozen things which people do to secure social approval. Evaluate the strength of this impulse. Trace its development to maturity. Do you think it is native and primary, or acquired and secondary?

14. Name a dozen instances in which a slight suspicion of disapproval brings great mental discomfort.

15. How much would you pay to see a good football game, if you were the only spectator on the bleachers? Explain.

16. When does the child begin to be self-assertive? What are the reactions when he is hampered or suppressed? How do habits of stubbornness arise? How would you deal with a stubborn boy?

17. It has frequently been said that our pioneer ancestors when they pushed to the frontiers in the great western movement in America suffered most acutely from lonesomeness which was alleged to have caused an unusual number of cases of insanity. Would such facts have any bearing on question of whether gregariousness and other social urges are native or acquired?

18. Which impulses are likely most readily to be gratified in the life of the teacher, the minister, the lawyer, the politician, the prize fighter, the argumentative person, the bashful man, the I.W.W., the Salvation Army, the laboratory investigator in science?

19. What impulses operate to make the following activities satisfying or annoying: the dance; a male group hike into the country; Christian Endeavor activities; hazing of freshmen; football for the players and for the spectators; smiles to acquaintances; praise of virtue; factory labor; domestic labor; sheep herding; confinement in prison; wearing war medals; wearing fine clothes; giving a big party; riding in a Ford; riding in a Rolls Royce; appearing in informal clothes at a formal dinner; facial blemishes; being a spendthrift; being a "jolly good fellow"?

20. Which of the experimental studies of the effects of motivation upon achievement suggest devices that could be used satisfactorily in school? Which types of motivation would you disapprove of? Why?

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CHAPTER VII

MOTIVATION AND PERSONALITY ADJUSTMENTS

In previous chapters we have considered in some detail the facts of motivation. We have observed that living organisms display activity primarily as a means of satisfying some craving, urge or want. Hunger is a good example of such an urge. Hunger is itself a response to stimuli. It is usually a continuing reactivity like the persistent contracture of a muscle. It is an urgent condition which arouses the organism to activity and ceases to be urgent only when certain further activities or adjustments have been consummated. Hunger is thus a motive or drive to action. Activity is, in general, motivated in this way and persists until some adjustment is made which relieves or removes the motivating tensions. Under the term motivation, then, we may include all the facts concerned with urges and impulses and under adjustment the facts concerned with satisfying these wants and cravings.

We have mentioned certain groups of motivating factors which are so characteristic of mankind as to lead us to call them the dominant human urges. It was not pretended that this list was exhaustive; only that it was representative. It was a list of general types within which were almost innumerable particular impulses aroused by many different external situations and internal conditions. Each specific urge has a life history. It started somehow at sometime and changed more or less during subsequent experiences. We are unable as yet to give the genesis and history of most of the types of cravings. In this chapter, we shall, however, try to indicate in some measure how these dynamic factors do motivate and guide our activities, our movements, thoughts, emotions, beliefs,—in fact, our general adjustment to the world in which we live. We shall see that a very significant phase of our adjustment consists in habit formation, or learning, and that, consequently, our strong cravings play a significant rôle in the learning process. This chapter thus forms a connecting link between the earlier discussions of motivation and later treatments of learning.

How Cravings Are Thwarted

It was stated in the preceding chapter that an impulse or urge is most conspicuous when it is not given immediate expression, when it is thwarted or delayed. The conditions of life are constantly thwarting the immediate and direct consummation of our cravings. A particular impulse, such as to sneeze, may be interfered with by physiological factors or by knowledge that it would be socially offensive. Every urge, whether a minor one or one of the general types previously described, is subject to restriction or inhibition more or less frequently. The sources of interference with the main urges may be grouped roughly as follows:

(1) Other insistent but antagonistic cravings.
(2) Acquired habits, ideals, conventions, taboos.
(3) Obstacles in the environment.

One craving may conflict with another or several others so that all cannot be gratified. Thus one's desire to accumulate may conflict with the counter desires to rest, secure immediate sensory satisfactions or social approval by immediate display. The impulse to mastery may conflict with the impulse to avoid injury in physical encounter. The urge to experience the novel may conflict with fear of the unknown or with the satisfactions of familiar surroundings. The craving to dominate, when the objects are our own children, may conflict with the parental impulse to treat them tenderly.

The strong cravings may be thwarted by acquired habits, ideals, religious beliefs, or social conventions. In time of war, instinctive fears of slaughter may conflict with ideals of patriotism. The impulses to pick up attractive objects run counter to habits and ideals of honesty. Beliefs established in childhood, religious and social training, or thoughts of consequences, may inhibit many sex urges. The strength of the impulses to collect and hoard, to dominate, to fight, to indulge sex are reflected by the Ten Commandments, and other religious as well as legal, economic and social enactments. Were these urges more easily and generally controlled there would be little need of laws and courts, police and prisons, social taboos and prohibitions. The existence of these institutions and practices is perennial evidence of the conviction that all fundamental drives are not socially desirable, and that many of them must, therefore, be more or less completely diverted or held in check.

Finally, strong impulses may be thwarted by natural obstacles or realities. Barrenness of the soil, floods or drought, business depression, the superiority of rivals or the death of parents, partners, friends, may thwart many urges. One's desire to secure social approval may be thwarted by a disfigured face; to attain mastery, by an unimposing physique or inadequate intellect. Injuries, illness and other misfortunes are the more annoying because they foretell other thwartings. If we have a steady job certain cravings, such as those for rest, freedom of action, display of authority, may need to be foregone; if we lack a steady job, others such as the desire to accumulate, to eat abundantly, to secure approval, are jeopardized. No matter how favorable the conditions of life, the thwarting of many primary impulses and wants will be constantly experienced.

WHAT HAPPENS WHEN A STRONG CRAVING IS THWARTED?

What happens when an insistent tendency, being in readiness to act, is by some circumstance not permitted to act? A general answer to this question is as follows: Whenever the organism is ready to act in some way, for it to act is satisfying; and furthermore, whenever the organism is ready to act, for it not to act is annoying. A satisfying state of affairs is defined as one which the animal seeks and attempts to maintain; an annoying state of affairs is one which the animal attempts to avoid or change,—to which it reacts negatively. Both are conditions which demand activity and if the conditions are novel, the result of the activity is learning.

These general statements find concrete illustration in experiments upon a cat inclosed in a puzzle box. The animal is annoyed by such confinement and this provides the motive for efforts to escape. If the cat is at the same time hungry, food placed in front of the box adds another motive—a readiness to eat. If the way out of the box has been previously mastered or if the box yields to such activities as cats usually make in such a situation, the end results—escaping confinement and reaching the food—are at once accomplished. But if the box is unusual, the way out must be discovered by a series of trials characterized usually by many errors before final success is achieved. Here we have a typical form of learning; learning by "trial and error" or "trial and accidental success" as it is called. The cat bites, digs, claws, pushes, pulls and makes other native and acquired responses to the several features, wires, slats, knobs, strings, openings, which the box provides; he tries and tries again, until finally the solution is hit upon, often by sheer accident. Usually the whole performance must be undergone a number of times before the "way out" reactions are thoroughly habituated.

In many instances, man's behavior when trying to satisfy some strong impulse is like that of the cat in the box. He tries in one way or another to secure the satisfying and avoid the annoying state of affairs. He differs from the cat by learning the "way out" of the latter or the "way to" the former more rapidly and with better retention. He differs, furthermore, in his capacity to make certain mental adjustments to the perplexing situation; adjustments which, although involving ideas to a degree quite beyond the capacity of the animal are nevertheless often achieved by the same "trial and accidental success" process that characterized the cat's escape from the box.

When the native impulses to collect and hoard, rest, dominate others, fight, secure social approval or sex satisfaction, or to satisfy other wants are thwarted by obstacles, or when they come into conflict with each other or with our acquired habits, beliefs or ideals, some way out of the dilemma is sought by the try-and-try-again process; that is, by means of our capacity to learn. The adjustments thus made are obviously acquired reactions; habits acquired in the service of the fundamental urges.

Individual Differences in Ability to Tolerate Thwartings

Individuals moreover differ greatly in the degree to which they are annoyed by the thwarting of their wants as well as in the characteristic types of adjustment. Some people, we all know from observation, can maintain their poise in the severest storm of deprivation and misfortune, while others are disarrayed by the slightest swirl. Scattered between the two extremes are the other individuals, representing every intermediate degree but most thickly clustered in the middle of the group. Those at the weaker end are often spoken of by students of nervous and mental disorders as "neurotic" or "psychopathic," which means, in a general way, easily upset, very sensitive to difficulties in adjustment, and consequently readily susceptible to nervous or mental disorders. The position which an individual occupies in the group, ranging from the most to the least "unstable," of which the "neurotics" compose the former end, is determined in the main by original nature, although disease, poisons, shocks, or hardships may pull one to a level far lower than his original position.

It is seldom easy to differentiate the neurotic or nervously unstable from the extreme case of general emotionality. In the purest form, the case of extreme emotionality represents merely an excessive organic reaction to stimuli. There may be internal disturbances of a violent type, momentary or persistent, with relatively little misinterpretation of the stimulating events. The individual may merely become readily embarrassed, chagrined, frightened, unnerved, angered, while quite aware of the irrational character of such behavior, just as many of us become more or less excited over a public performance while quite aware both of the irrational character and the futility of the perturbation. The emotionally unstable individual may make entirely rational and wholesome adjustments to his difficulties even though the difficulties are great, whereas the psychopathic individual is not only intolerant of his thwartings but is unfortunate if not irrational in his adjustments. Emotional susceptibility, however, predisposes to unfortunate adjustments and unfortunate adjustments may aggravate emotional susceptibility.

What is meant specifically by the extreme neuropathic or psychopathic dispositions can best be explained by detailed consideration of particular adjustment tendencies of which there are several forms.

ADJUSTMENT BY SURRENDER

One method of meeting thwartings of our cravings is to give up, submit to defeat, admit the superiority of the persons or circumstances blocking the way. Since one's cravings usually do not subside in such a case and since, often, as in the event of hunger and thirst they become more acute as they go unsatisfied, the adjustment of surrender can rarely be more than a temporary expedient. Moreover, to admit incompetence—save when done to arouse sympathy for us or to encourage others to reassure us and thereby to increase our courage—brings one of the most disagreeable annoyances, the feeling of inferiority or the "inferiority complex." The victim of this condition is in the doubly desperate strait of being annoyed not only by deprivation of the original craving but by the feeling of inferiority as well. This feeling, often long smoldering in individuals, is a symptom of inadequate, unconstructive adjustment.

ADJUSTMENT BY DIRECT ATTACK

Another method of adjustment consists in conflict, in giving direct battle to the thwarting factors. Many forms of direct attack are wholesome and constructive but others are unwholesome and destructive. The thwarting of one's cravings tends to provoke physical combat as when a boy attacks his tormentor or a man struggles with a balking mechanism or a nation makes war upon a rival. In most forms of combat, the emergency mechanisms underlying the emotions come into play. The danger is that the attack, stimulated by the emotion, may become an unreasonable form of violence which leaves matters worse than they were. Thus the boy may be injured as well as tormented; the man may only further incapacitate the balking mechanism, and the warring nations may destroy more property and happiness than either gains through victory. The direct attack, while it possesses a positive quality not found in the "giving-up" adjustment may sometimes be unwholesome and futile. In most cases, however, the positive attack upon the causes of difficulty, especially when it can be conducted calmly and intelligently, is the most wholesome and constructive of all forms of adjustment. There are, however, individuals who will not, or cannot always adopt this form of adjustment even when it could be effective and there are instances, as we shall see later, in which it would be futile when used.

Adjustment by Introversion or Imagination

A direct fight to secure the conditions craved and a deliberate surrender to the thwarting circumstances are not the only means of adjustment. There are others, some of which are easier than the first and less annoying than the second. One of the easiest, and often one of the most satisfying methods is the mental adjustment technically termed *introversion* (meaning to turn inward) or *imagination*.

Introversion is a kind of giving-up adjustment, yet it is not a complete surrender. It consists in giving up the ends sought, but substituting for them an imaginary realization. Quite as children daydream about candies, toys and playmates that they cannot secure, so adults realize in imagination the wealth, social approval and conquests that are in reality denied them. The child or adult who has been angered, instead of actually fighting or admitting defeat, imagines himself inflicting dire punishment upon the offender. The imaginary companions of the lonesome child, which occasionally become phantasies, the "white lies" due to confusion in recollection between the real and the fancied are the products of similar mental mechanisms. In extreme form, the adult *introvert* (*i.e.*, a person subject to excessive daydreaming) at least when subject to confusion of fact and fancy, would be classified as abnormal or insane. The delusions of the insane thus appear to be merely exaggerated forms of the daydreaming of normal persons.

The "Conquering Hero" Type.—Among introversions there are several tendencies which are alike with respect to the mental processes involved and with respect to the fact that they are, in some way, clearly satisfying. Perhaps most common is the form in which various strong impulses—the urge to secure social approval, mastery, etc.—are gratified by playing one's self, in imagination, as a "conquering hero." One may picture himself as a hero in battle, on the gridiron, in the prize ring; as a great bandit, singer or preacher; as the strongest, most admired—indeed, as the superlative in any line, even in benevolence or modesty. By some imaginary ability or achievement one becomes an extraordinary person—a conquering hero—to whom imaginary approval and applause are due.

These are perfectly normal and universal daydreams which bring much satisfaction and little harm to most people. But in the extreme form they may be disastrous; indeed, they resemble the delusions of grandeur found in paranoia, a form of insanity. The victim of delusions of grandeur has become an extreme introvert or has somehow lost his grip on reality so that he believes and tells you at length that he is the strongest, wealthiest or in some other way the greatest man on earth. Of course, these systematic delusions indicate neurotic organization to begin with and may be long in developing into the extreme form; but fundamentally they are achieved by the same kind of mental functioning which results in the harmless self-aggrandizement of youth and the ordinary, flattering daydreams of adults.

The "Suffering Hero" Type.—Another tendency of imagination or introversion is typified by the ideal experiences of a suffering hero. While less frequent than the conquering hero variety, this form of imaginary experience is equally intelligible and equally satisfying, to some people, at least. The fancies may run something like this: a boy, ruminating over his hard luck and ill treatment (as he sees them) at home, pictures himself as forced to run away from home. He imagines himself joining a group of bandits and going to the bad completely, or perhaps overwhelmed by a snowstorm or wild beasts, by which he is injured or even killed. Meanwhile, parents, teachers, some little girl, in fact the whole village has become alarmed and repentant, and after vigilant search he is brought back a hero, even if a wounded one. But perhaps he dies, and if so, it is anything but annoying for him to hear the imaginary obituary, in which his virtues, appreciated heretofore by none but himself, move the congregation to heart-rending grief and remorse.

Introversions of this type are highly gratifying partly because the subject is, after all, a hero who achieves acclaim and partly because approval coupled with sympathy and pity are all the more sweet. Self-pity, which is typical of many neurotics, is well fed by introversion of the suffering hero type.

The suffering hero mechanism is often behind such childish behavior as pouting, sullenness, pretended injuries or illness, refusals to eat or to play. If the new doll or dress is not quite up to expectation, the child is angered and will not have it at all. A real or imagined slight at the party sends the boy home in indignation or grief. As a rule, real actions of the wounded-hero type are cured more readily than are thoughts. The boy who refuses to eat finds, after all, that no one else is much disturbed, whereas he gets dreadfully hungry; he who leaves the party learns that he misses a great deal of fun without being himself missed. But the imagined acts of this sort come out more happily. Imaginary starvation is more tolerable, and the imagined remorse and pity caused by it can be secured, whereas real sympathy from others is not always forthcoming.

Some forms of delusions of persecution in the insane have many features in common with the suffering hero introversion although others are developed in different ways. Overt acts of martyrdom, ranging from refusals to eat or play to the infliction of injuries upon one's self, from the simulation of illness to actual suicide, may be the outcome of prolonged or impulsive introversion of the suffering hero type.

Identification.—A somewhat easier and often more vivid substitution for genuine action of the sort which is desired may be secured by identifying one's self with the conquering or wounded hero or with other characters in fiction or on the screen or stage. When the boy reads *Treasure Island* or *Robinson Crusoe* he actually becomes the adventurer. With Nick Carter he holds up trains, kills Indians, overcomes ferocious enemies, drops over

Niagara, and has other experiences at which his original nature thrills but to which it scarcely dares lead overtly. Similarly, we may identify ourselves with the righteous and heroic sufferer, and weep real tears at our imagined hard lot. The heroes and heroines as well as their experiences may change constantly or, doubtless less frequently, we may persistently identify ourselves with a real or represented character, following his achievements in great detail. The rôle of the finest character or the greatest rogue, the most applauded or the most chastised, may be the object of identification and thus lived in imagination with great satisfaction.

Within limits, and properly controlled, the play of imagination or identification is productive of little harm, while providing much satisfaction. The student, struggling without time or means for immediate gratification of many desires, is comforted by the vision of wealth, power and approval that he may some day attain. The introversions should be of the right sort, however. Imaginary achievements as a rule, if not invariably, are more wholesome than imaginary grievances. One may get along very well on imaginary power but not very well on imaginary food. Fancy must not disregard fact nor become a substitute for action. It is in this possibility of imagining fine adjustment while achieving none that danger lies. It lies in the formation of habits of retreating from, instead of actually facing, reality.

ADJUSTMENT BY RATIONALIZATION

Mental adjustments may also take the form of rationalization although irrationalization would be the more descriptive if less commonly used term. Rationalization is a form of thinking or reasoning, that is, of sifting data, in which our personal cravings are selective factors which guarantee an agreeable conclusion. Ideally, reasoning is the process of impartial manipulation of the evidence to achieve the logical conclusion, however disastrous the result may be to our own desires. Rationalization means more or less complete blindness to all evidence except what furthers our side of the case. In everyday life this irrational process is often so subtle as to leave us oblivious of its existence. It is the basis of most forms of bias and prejudice.

The Rôle of the Main Impulses in Rationalization.—A middle-aged man with a wife and family buys a handsome automobile. His older and more sagacious uncle, paying a visit, questions his motives in this purchase: "It seems to me," he says, "that you need furniture, a new fence, a fund for sending your children through college, a nest egg for emergencies, more than you need this machine." But the buyer has a ready defense. "Well, my wife hasn't been any too well and I thought that a little week-end trip now and then would do her a lot of good. And a business man must have some recreation, you know! Then the children. They caught so many colds last winter because they got wet going to school"—and so on with other "reasons." Now, what were the real motives? Perhaps the fact that other neighbors had cars which were veritable badges of greater business success. Perhaps driving a big machine appealed to the urge of self-assertion. Perhaps the approval of onlookers was the object sought. Observe the motives to which advertisements of high-class cars appeal!

The real motives often lie deeper than those we give, and what is equally significant, we often do not ourselves appreciate just what they are. Rationalization is a subtle process; it provides acceptable reasons while concealing the fundamental motive. The most effective temptations are those which come in disguise. If we are inclined to take the afternoon off for golf, while really aware that we should work, we at once obscure the real issue by rationalization, by camouflaging the unworthy impulses. The student says to himself, "I have been working hard; I deserve a rest; I must be careful of my health; a little recreation will double my capacity to-morrow." And the next morning, to justify faith in himself, the student rationalizes the sore muscles and aching back as symptoms of renewed strength and vigor; or the excessive fatigue as evidence that exercise was sadly needed. These excuses and explanations are as persuasive as they are irrational.

Projection.—Failure to secure mastery, social approval, or to satisfy other strong urges may be partly averted by a form of rationalization called projection. There is a universal impulsion to project the trouble to some cause other than our own deficiency. If, while groping our way across the room in the darkness, we thump our shin on a footstool (due to our own forgetfulness), our immediate impulse and not infrequent act is to reproach the footstool rather than ourselves. Missing a stroke in tennis, we look inquiringly at the racket, ball or net. The clumsy carpenter accuses his tools. If we fail in an examination, the questions were unfair. If one is a slave to alcohol, the taste was inherited from one's father. If a man sins, it was because he was irresistibly tempted. If he amounts to nothing, it was because he did not have a chance. There was once a man who exclaimed when his carelessness resulted in the burning of his home: "It was the Lord's will."

By projection we escape the annoyingness consequent upon the admission of our failures and deficiencies. The chronic alcoholic, notorious for projecting the cause of his downfall, affords an example of this mechanism. It would be most painful to admit that one is not only a worthless drunkard but also the cause of untold suffering to one's wife and family. The chronic drinker, finding it impossible to give up the liquor, casts about, like the cat in the box, for some means of escaping these unendurable thoughts. Perhaps, sometime as he arrives at home intoxicated, the wife indignantly drives him out of the house. Thinking the matter over at the "blind-pig," it occurs to him that he would not be drinking now were it not for his wife. This affords a crumb of comfort. He broods over this and other real or imagined events until he has convinced himself that his wife has been, even from the beginning, the cause of his downfall. He has literally been driven to drink. That these delusions free him from responsibility not only for his own ruin but for the sufferings of his family is motive enough for clinging to them tenaciously.

The "Sour Grapes" Mechanism.—As the fable goes, a fox, after many vain efforts to secure an attractive bunch of grapes, preserves his pride by declaring that the grapes were sour; quite unfit for consumption by one of his caliber. This portrays a common method of human adjustment, a tendency to minimize or deny the desirability of the ends sought. If we lose our job through inefficiency we convince ourselves that the loss was a blessing in disguise. If we find masterfulness difficult to attain, we may say that more than anything else we despise pretentiousness. Being poor, we assert that money is the root of all evil. Unfit for or unsuccessful in marriage, we declare wedded life a failure.

A rather general belief in compensation among human abilities has arisen from this tendency—a conviction that people extraordinarily competent along one line must be deficient in another. If the other fellow learns rapidly he will retain poorly. The pretty girl has little sense. The highly intelligent are nervous, unstable or physically inferior. All of these generalizations are, in fact, incorrect and thus disclose the more clearly this unique human tendency.

The "Sweet Lemon" Mechanism.—A fox finding none but sour grapes declared that they were really sweet; just the kind for which he had been searching. And so, Pollyanna finds that no matter what the calamity, one ought really to be pleased because it might have been worse. Living in a hovel, we declare it easier to keep tidy and much more comfortable than a big lonesome house. Lacking mastery, we find supreme virtues in meekness.

The "sour grapes" mechanism and the "sweet lemon" form of adjustment betray a weakness. To declare that really desirable achievements or rewards are futile or depraving seldom relieves our wants, at least not those grounded in strong native trends. Furthermore, the fruits whose desirability was once denied later may fall within our grasp, whereupon we must either scorn them again or else lay ourselves open to the attack of inconsistency.

Both forms of adjustment are negative—let things come as they will and make the best of them—rather than progressive. It is the adjustment of the inactive; the same old sour grapes are good enough. If they are really sour, it would be better to search elsewhere for sweeter ones. It is the opposite extreme of adjustment tendency from the behavior of one who, finding a high wall in the path of his progress, attempts to go under it, or over it, or around it, and, all of these failing, goes around the world to come up on the other side.

Prejudice and Logic-Tight Compartments.—Systems of ideas developed by rationalizations of any type, beliefs, superstitions, prejudices, grudges or habits developed in childhood or later often become so firmly established that they can scarcely be dislodged even in the face of substantial evidence that they are irrational, useless or even vicious. Such acquired systems of response, impenetrable to logical attack, have been called logic-tight compartments.

Among the milder forms of logic-tight compartments are our convictions of the superiority of our town or county, our college, or ourselves. Several investigations have shown a very usual tendency for people, even those of high intelligence and broad training, to overestimate their abilities and virtues and in particular for those who are generally regarded, for example, as decidedly snobbish or vulgar to be blind to the facts. It is easy to see that these erroneous beliefs are motivated by our fundamental desires. In various ways we may close our minds to the arguments which run counter to our wants and cherish those which favor them. In the course of time, these prejudices become fixed.

We may have closed minds in various degrees, ranging from the slight distortion of facts required to provide a comforting explanation of failure in an examination, or that of a male clerical worker who may not himself see any relation between his fear of competition and his conviction that "woman's place is in the home" to the extreme type of the man who, while scrubbing the floor of the asylum, stops to tell you that he is a millionaire. While we would call the last a case of insanity and the first just a "natural feeling," both are similar mechanically, differing mainly in the degree to which misinterpretation is carried. The delusion of being a millionaire represents logic-tightness to a degree of absolute immunity to which the term dissociation is often applied.

ADJUSTMENT BY DEFENSE AND ESCAPE MECHANISMS

Psychologists and psychiatrists frequently classify as dissociations not only systems of ideas or prejudices but also bodily functions. A patient may be at times uncontrollably nervous, hysterical or morbid; he may be weak, paralyzed in one part or another, blind or deaf; he may have pains, seizures, fainting or vomiting spells, dizziness or heart disorders. The term dissociation is here merely descriptive; it indicates that some function has been broken off from control of the "main" personality. What interests us in these cases is that, while not the product of rationalization as heretofore described they are sometimes none the less acquired as the result of some motive and may persist as long as the incentive continues. The motive is rarely understood by the patient. The symptoms are the result of what is called a "defense mechanism" producing protection from some distasteful or fearful task or condition or "escape mechanism" affording an escape from some annoying or horrifying task, or condition in which the patient finds himself.

Samples of Defense Mechanisms.—A badly pampered young man of a somewhat unstable type began his career as an accountant. Before many weeks he was brought home complaining of severe pains in the eyes and in the right arm, which seemed partly paralyzed. Feeling better after a few days' rest, he returned to his work, only to find the attacks recurring. The significant thing about these symptoms is that they made his work in the office impossible. Actually, the young man found the tedious task at the desk, day in and day out, extremely boring, and the work deprived him of the freedom and comforts which home life had previously given. At the same time, he was naturally averse to quitting outright—that would offend his self-respect and bring the scorn of his friends as well. Perhaps, one afternoon the fatigue of eye and hand did become severe, providing an excuse for release from labor for the day. The next day, the same symptoms occurred in more severe form and, half frightened and yet half gratified, he was taken home. Not only did he thus escape the unpleasant work but also the criticism of himself and of others as well. In fact, he reaps more sympathy, freedom and general care than ever.

Psychoneurotic Disorders Considered as Defense Mechanisms.—Many of the "psychoneurotic symptoms" of soldiers during the war (often called "shell-shock" improperly since they frequently appeared in soldiers who never reached the front) were of the same general type, similarly occasioned. It should be observed first that the symptoms, such as paralysis of the arm, fainting spells, temporary blindness, vomiting, etc., provide "escape" from or a "defense" against arduous or dangerous military activities. It should be stressed again that such symptoms do not imply pure malingering; they are unintentional, although motivated by human tendencies to seek safety and ease and avoid danger and hardship. They are as perplexing and unintelligible to the patient as to others, but they result, nevertheless, in "escape" and often bring unusual care, attention and sympathy. The remarkable, and yet wholly intelligible, thing was the rapid disappearance of the psychoneurotic disorders after the Armistice was signed. The motivation, the incessant stimulus which kept them alive, was suddenly removed; and as subtly as the symptoms appeared in the face of war, they began to disappear with the certainty of peace. The symptoms were no longer a defense against the labors and danger of war but a prevention of exchanging the confinement of the hospital for the freedom of private life. Many of the symptoms disappeared abruptly, others slowly, still others like other unfortunate habits were more persistent. Thus subtly is conduct guided and controlled by our fundamental cravings.

ADJUSTMENT BY SUBSTITUTE ACTIVITIES

The various forms of introversion and most of the forms of rationalization were mental adjustments to the situations which interfered with or inhibited the direct expression of native impulses. In one way or another some mental activity was substituted for overt action. More active adjustments may also be made even when the substituted activity is in most respects quite unlike the original form. For example, a man who has been enraged but who does not dare to give rein to his impulses to attack because of his fear of injury, or jail, or perhaps because he doesn't believe in fighting, may substitute an attack with words or looks, or he may control himself for a long time but may later vent his rage upon his wife or children. In the same way, a man of frail stature, failing to secure a feeling of mastery by his physique, substitutes (quite unwittingly, perhaps) a dignified gait and manner, or develops a loud, "masterful" voice, or a hard, even gaze. A woman, lacking beauty or wit, may, to secure approval, adopt gorgeous apparel or affect the élite in vocal expression. The unprepared student in writing his examination may compensate in volume for what he lacks in facts. A man low in the scale of authority at his place of work, submissive to others throughout the day, may find a satisfactory substitute in ruling his wife and children with a stern and unrelenting will.

Undesirable Substitute Activities.—Substituted activities may be good or they may be bad; some are very bad indeed. That addiction to alcohol, heroin, morphine, or other drugs may be considered as compensations for thwarted desires or ways out of annoying situations, is a growing belief. Dr. Richard Cabot, Professor of Medicine in Harvard University, writes: "We hear a great deal of the physical craving for liquor. I do not believe there is any such thing except in the people who are in the middle of a drunk. A person who has slept it off . . . may well enough go back to it and of course he often does. But he does not go back from merely 'physical' craving, but generally because he is bored or because he is blue or because he is restless." That Dr. Cabot had in mind thwarted impulses or annoying conflicts from which alcohol has provided an escape, is indicated in this further statement: "The alcoholic is helped, so far as he is helped at all, by getting at the reason why he started drinking and has continued to drink. Then if possible we try to find a stronger motive, a motive stronger than the thing that has driven him to drink and thus drive him out of drink."

More Desirable Substitute Activities.—A substitute activity, then, may get one into difficulties worse than the trouble which the activity aimed to relieve. But there are good as well as bad forms of compensation. If the maternal urges are thwarted, better than idle daydreaming, or novel reading, or a pessimistic view of life, or "sour grapes" or a cheery indifference of the Pollyanna type, better than some silly or harmful compensatory activity, would be the substitution of some social, religious, or educational work. For the fighting, hunting, dominating impulses of youth, vigorous athletic games may be substituted. When angered, instead of holding a grudge, or inflicting damage on the offender in fancy, or working off the impulses by verbal attack upon inoffensive persons, we might attack the woodpile. A man who had lost his wife and children, in a terrible calamity, instead of avoiding the anguish by way of delusions, or liquor, or giving up to a wounded-hero type of self-pity, plunged more deeply than ever into his work and so instead of becoming a "ne'er-do-well," a drunkard, or a pessimist, became a very eminent soldier. Of all the methods of adjustment to the thwarting of our fundamental impulsions, the substitution of some wholesome but vigorous activity, while not always the easiest to arrange, is by far the best. When the lives of men are deeply searched, great achievements are sometimes found in activities which began as substitutes for some other interest that was thwarted.

ALLEGED ADJUSTMENT BY REPRESSION INTO THE UNCONSCIOUS

In the writings of Freud and many other exponents of the "psychoanalytic" schools, the term "repression" into the "unconscious" or "subconscious" appears extensively. According to many of these writers, repression is conceived as a subtle mechanism by which many thwarting or painful ideas or "conflicts" or impulses under taboo may be temporarily avoided by banishment from consciousness. Sex impulses (which the Freudians find to be most numerous) may arise in forms tabooed by our ideals or training. We cannot allow these impulses to be relieved directly or even by daydreaming their realization. Attempts to rob them of their attractiveness by some form of rationalization, by the "sour grapes" mechanism, for example, may fail. What we may do, according to the Freudians, is to relegate them actively into the subconscious; that is, to repress them. Once submerged in this lower region, they become unconscious—we become unaware of their existence—but though buried they are really buried alive. Still active, they may express themselves in some indirect way, often in most mischievous ways.

They may come out during dreams—a time when our inhibitions are at a low ebb—in some symbolic or even direct form. During waking hours, the repressed ideas or impulses are more closely guarded by the "censor," that is, by our ordinary taboos and inhibitions. Their appearance then must be very deceptive; consequently they take the form of headache, nervousness, fears, forgetfulness, pains, paralysis, or stuttering. Even slips of speech or writing, difficulties in recalling a name, an appointment, or a tune and giggling are ways in which repressed impulses are satisfied. Many nervous disorders, it is said, are occasioned by these unconscious ideas and impulses. Such symptoms are unconscious motives in disguise.

When explained in detail, the Freudian concepts are fascinating and often convincing. Yet they have not met with approval in most scientific, especially psychological, circles. The trouble is that while they fit in well with popular notions, the concepts are really scientifically unsound.

The Unconscious and Subconscious Ideas.—There may be, in the body, activities which are unconscious; that is, activities which arouse no sensations. Our digestive processes may be going on, active yet unconscious. The seat of consciousness is, of course, the brain and not the stomach. Unless the motor and glandular activities, through sensory nerves, arouse to activity certain neural mechanisms in the brain, the digestive processes arouse no sensations, that is, they do not become conscious. The trouble begins when it is assumed that the sensations from the stomach, even if not experienced as conscious, nevertheless actually exist somewhere, namely, in the unconscious. The fact is that unless they are conscious they do not exist at all—in the subconscious mind, in the brain, or in any other place, any more than words exist as things in the vocal organs when these organs are inactive. "Where," it is asked, "is a memory or idea when it is not conscious? Where is the idea of my birthplace when I am not thinking of it? Is it not still a genuine, live idea although not in the region which we call consciousness? Given a chance, will it not leap out of the unconscious into full consciousness? Is this not the process of recollection?" Now this doctrine is as perverse as it is simple. Memories and ideas are not things, which must always exist somewhere. They are merely conscious responses to appropriate stimulation just as movements are muscular responses to stimuli. We do not say that a movement is something actually existing but concealed in a muscle, from which it emerges when activated and to which it returns during inactivity. What we say is that a mechanism, the muscle, when properly stimulated by means of a nerve impulse, is thrown into action, with a movement as the result. During a period of inactivity, the muscle does not contain an actual movement; all that exists is the muscle with its nerve connections modified as they have been by past exercise. Likewise, the physical basis of conscious recall is assumed to be a group of neural mechanisms similarly conditioned by past exercise and thrown into action by stimuli. In sum, an idea, memory or impulse is like a motor response, in the sense that it is a reaction. It is retained in the same way that an acquired motor act is retained. Neither a movement nor an idea exists as such except when it is activated; at other times, neither exists in the unconscious—it is simply inactive.

Unconscious Impulses.—Impulses to eat, sleep or dominate are, like movements or ideas, due to reactions of certain mechanisms; and except when the mechanisms are active, the impulses do not exist. The impulse to eat, for example, is produced on occasions by organic conditions such as that of insufficient fuel in the system, or by outer stimuli such as the sight or smell of food, or—best—by both together. Readiness to eat does recur, not by popping out of the unconscious but as a reaction to organic or external stimuli. Similarly, the sex impulses are aroused by certain bodily conditions or by an external stimulus or by both together. Impulses, like memories, are reactions; they exist only when active; at other times there is nothing except the mechanism on which they depend. When not in a state of activity, impulses do not actually exist as entities in the unconscious or in the mechanisms which give rise to them any more than snaps and pops exist, as such, in an inactive whip.

These are really not trivial or academic "distinctions without a difference." The Freudians, having gone astray because of the erroneous assumption that every one carries around with him a host of active entities in his unconscious mind, assume that these hidden but uncannily active—in fact, intelligent—beings disguise themselves and break out, causing slips of the tongue, dreams, fears, nervous disorders of the various sorts which they find in their patients. There is a tremendous difference between the Freudian statement that the accountant's eye and arm disturbances (mentioned above) are due to the work of active entities from the unconscious and the explanation that these troubles were actually learned in much the same way that the cat learns, after many errors, to pull a string which opens the box in which it is confined.

Inactive and Dimly Conscious vs. Unconscious Ideas.—This Freudian mechanism of avoiding unpleasant thoughts or impulses by actively pushing them into the region of the unconscious where they still exist and stir up trouble—psychoneurotic symptoms, for example—we cannot accept as true or useful. That we do attempt to avoid unpleasant thoughts and impulses is not denied but strongly affirmed. Mainly our efforts to forget are efforts to substitute another activity. A frequent device, when one thinks of some social blunder, or some undesirable impulse, is to begin to sing, write, read or do something else. We get the unpleasant idea out by getting another one in. The unpleasant thought or impulse may still persist in the background of consciousness and still influence our behavior as the dim awareness of an important event influences our activities and moods, or they may disappear entirely from consciousness. In the latter case, the ideas and impulses are merely inactive; they are not relegated to a different region where they still remain active in mysterious, not to say, fantastic ways.

Summary with Certain Implications.—The various typical ways by which man escapes the annoying situation occasioned by the thwarting of his desires by daydreaming the activity, by "sour graping" it, or by pretending that the annoyingness is really satisfying, by rationalizing an excuse for the indulgence, or by substituting some other activity, good or bad—all of these are acquired adjustments. They are learned reactions, just as speaking English, fearing the plague, or cracking nuts are learned reactions or habits. To say that they are learned is by no means to say that they are understood. Just why or how, and often when, he learned to enjoy stories of travel, to whistle or to count, generally is not understood by the learner, nor does he usually know with any definiteness how he now whistles or counts. The purpose of this chapter has been to present in general terms a number of acquired adjustments to annoying situations provoked by the hampering or thwarting of fundamental tendencies to action; and to illustrate the fact that many habits are formed in the service of the dominant cravings. The detailed processes involved in learning or habit formation remain for later chapters and in none of them will it be found necessary to invoke the use of uncanny subconscious or unconscious entities or mystic powers of any sort.

REMEDIAL MEASURES AND "CURES" FOR UNFORTUNATE PERSONALITY ADJUSTMENTS

The Prevalence of Psychoneurotic Ailments.—That our adjustments to difficulties are both good and bad, that they vary from mild and quite harmless habits to most severe "psychoneurotic symptoms" has been stated. Not infrequently the unfortunate defense mechanisms or compensations, excessive introversion or other adjustments are such as to interfere with normal contented living. The victim believes he is ill, as indeed he is, but the illness is in the realm of general behavior and is not a disease in the ordinary medical sense. It is said to be a "functional" or "nervous" rather than an "organic" disturbance. It is often severe enough to cause the victim to search for expert advice or aid. "Half of any general (medical) practitioner's ordinary work," writes Dr. Richard Cabot, "is concerned with some type of psychoneurosis; not half that the neurologists do, but half that all of the doctors in the country are doing to-day, is to treat psychoneurotics. That is important in many ways. It seems to me most important, because very few of the doctors have ever been trained to treat a psychoneurotic; very few have an interest in it. The attitude of many a doctor is expressed by his desire to run out of the side door when one of these patients appears at the front. He hates them, but cannot afford to show it." By this statement of an eminent physician, two facts are implied: Disturbances in behavior generally of a character serious enough to occasion a visit to a doctor are as numerous as organic disease and treatment by ordinary physical measures are apparently of little value.

How Such Ailments Are "Cured."—The histories both of medicine and charlatanism are filled with stories of "cures," supposedly of disease, but really of psychoneurotic symptoms or ailments. The psychoneurotic soldiers, above mentioned, were "cured" when the conditions surrounding their symptoms were altered, when the motives were removed or reversed. Usually the "cure" was effected only after some "treatment." What the treatment should be would vary with the individual; for some a strong electric shock, for others exposure to complicated apparatus, for others drugs, for others suggestion or a heart-to-heart talk. The "treatment" was really but a stimulus to arouse a change about to occur, a mere signal to move in a new direction. All down the ages this has been true; marvelous "cures," one after another, are given the credit for the change fundamentally due to a shift in motivation.

The Varieties of "Cures."—The main requirement in such a cure is that it shall be notable or novel or nasty. Cures by legions have been affected by notable personages, novel appliances and nasty nostrums. Valentine Greatrakes in the seventeenth century by the laying on of hands, Pfarrer Gassner in the eighteenth by word of mouth, Phineas Quimby of the nineteenth by his "magnetic eyes" and strokings, Émile Coué of our day by suggestion and incantation have "cured" hundreds or thousands of the typical psychoneurotic symptoms—pains, lameness, contractions, dumbness and so on. Less eminent curers were effective, too, on a smaller scale, such as the traveling "doctor," who has long been with us. Uncle Henry describes him thus for *Collier's:* "The doctor I remember best was Professor Hieronymus—vital healin', he called it. No knife, no medicine nor nothing. Why, magnetism poured out of him like sap out of a sugar maple. For $2 he'd take plain tissue paper between his palms and vitalize it, an' all you had to do to keep well was just pin it on your night shirt at the back over the great nerve center of the human body." Before his day primitive tribes had their "medicine man."

Similarly effective has been the use of mechanical appliances; in which novelty, something new or mysterious, is of prime value. Thus when the first inklings of electric forces began to flow, magic "tractors" (sometimes made of wood), electric belts, batteries and especially highly complicated and spectacular apparatus began to accomplish cures. The blue-glass craze, during which hundreds were supposed to have been cured of all sorts of ailments, was reputed to have originated in the humorous remark of a wag to a sufferer that blue glass should cure illness because the rays were "actinic." Quite aside from their legitimate functions, X-rays, radium, plasters, chest protectors—especially red ones—etc., etc., have been potent in relieving psychoneurotic symptoms. Drugs have been equally potent, especially nasty drugs—few have much confidence in a drug as bland as water. Theriac, of fame a century ago, made of a mixture of everything that tasted bad; asafetida, of a bad odor, which many of us as children carried in a little bag hung round the neck with a string; strong bitters, stinging liniments, violent physics, repulsive lotions such as "skunk oil" or crushed vermin and patent nostrums of innumerable sorts have in their time rendered "cures."

The Essence of the "Cure."—These cures are possible because at almost any time a goodly number of the cases of psychoneuroses have been relieved of the motive responsible for their symptoms. Being ready for the cure, almost anything which has a wide and startling repute may appear to affect the cure. Where the incentives of the symptoms still persist, patients are rarely cured, at least permanently, but given the moment when the symptoms have lost their function, conditions are ripe for a cure. In these moments it is better to be the subject of a marvelous new cure than merely to throw away the crutches and walk; the latter may arouse suspicion, whereas the former carries with it considerable prestige.

Because of these facts, there is wisdom and justice in the coolness with which men of science view the numerous new types of mental cures. The mere fact that apparent cures, even apparently marvelous ones, are wrought, is by no means convincing evidence of intrinsic merit. Many of the forms of psychoanalysis, Couéism and other cults, have yet to demonstrate their fundamental validity. They may remove symptoms without effecting a real cure.

Real Cure a Psychological and Educational Problem.—For all types of distorted personalities, the chronic introvert, the "sour graper," the rationalizer, the closed mind, the subject of unfortunate compensations or defense mechanisms, whether mild or extreme, the proper treatment consists in a thorough psychological study of the patient and his symptoms and the provision of remedial measures specifically fitted to the conditions revealed. For the more serious cases, treatment comprises the following five steps:

(1) The nature of the abnormality, particularly its incentives and history, must be discovered in the course of a careful psychological examination.

(2) The patient should be given to understand, as well as possible, the causes, nature and history of his difficulty. This step is usually advisable since the patient's coöperation in the remedial treatment is essential; he must

realize that cure will be achieved not through the passive use of drugs, appliances, rest or magic verbal formulæ but through active readjustment of his behavior.

(3) The patient must be re-motivated in the direction of getting well. The examiner, realizing that the patient will not really wish to get well merely because he is requested to do so, must so change the patient's ideas, activities and environment as to produce a motive opposing the old symptoms and favoring a different form of life.

(4) The patient must achieve confidence that he can and will get over his difficulties. This confidence is not expected to appear upon request but as the result of careful education or reëducation.

(5) Special steps in reëducation, beyond those required to accomplish steps (3) and (4), must be carried out to produce a more satisfactory mental attitude toward, and more fruitful activities in the activities of everyday life. These steps cannot follow a general prescription but must be adapted to the patient's special mental conditions, his intelligence and previous education, his specific aptitudes and inaptitudes, his financial status and other relevant conditions. They must be directed not merely to relieve particular symptoms but to provide the patient with the attitudes, activities, vocational and recreational skills which will make possible a new type of living that is more satisfactory than the old.

Study of many of the "cures" and new cults will show that in various ways they take into account one or more, but never all, of these requirements. To cure completely, diagnosis and treatment must include all of these steps.

In this chapter we shall be unable to discuss specifically all of the problems which are encountered under each of the general steps. An understanding of general psychology, that is, of the fundamental urges, feelings, emotions, constructive and destructive mental adjustments, intelligence, etc., will be essential for diagnosis, and comprehension of the principles of learning and relearning will be needed for the remedial measures. These and other relevant topics will be continued or taken up in later chapters. The diagnosis and treatment of distorted personalities, in other words, is one field for the application of the principles of general psychology.

Maladjustment, Diagnosis and Remedial Education of School Children

All of the types of maladjustment mentioned in the chapter are found among us from infancy to adulthood. We have described the psychoneuroses of adults merely because, being more extreme cases, they are more conspicuous. They show how serious ordinary adjustments may become. We find the same types of symptoms, produced by the same mechanisms, and corrected by similar diagnosis and remedial treatment in nursery, school and college.

Some forms of "negativism" so prominent at the age of two, outbreaks of temper at six, bullying at ten, smartness and mischievousness at fifteen, are typical forms of behavior acquired as means of satisfying fundamental cravings. Shyness, withdrawal, haughtiness, sulking, are often means toward similar ends. Difficulties, too, like distaste for reading, or "disabilities" in spelling may sometimes be traced to peculiar forms of motivation. To illustrate the latter sort of case, the following passage is quoted:

> "The writer's experience is that when one finds pupils who learn a little and then forget it, one should immediately investigate the possibilities of an unusual motivation, of incentives that make it, on the whole, more satisfying for the

pupil to be a non-reader than a reader. All of the pupils, observed by the writer, who failed to respond to any method of remedial treatment were probably of this sort. In dealing with such pupils, one must discover the motive, and, if possible, so change the circumstances as to make it more satisfying to the pupil to be a reader than to be a non-reader.

"One of these pupils was a boy of less than average intelligence, appearance, wit, strength, agility, and most other prized traits. He had distinguished himself from the ordinary child in his early years because of his difficulties in reading. Soon he had become quite conspicuous, and in time a notorious character—'The guy that nobody could teach to read.' He was sent to the oculist, to the doctor, to the principal. He had this tutor and that supervisor attempt to teach him. Always he made a little progress until, after he had exhausted the novelty of the new instructor or place, he lost all he had gained. The next examiner found his ability to be nearly zero. He was carried downtown to a neurologist, a fact celebrated by his friends and family. He was taken uptown to a psychologist. After several enjoyable trips, the report went around that these specialists had failed to teach him to read. At length the boy was removed from town for medical attention. He disliked the new locality. To earn the privilege of returning to his home and school, it became necessary to learn to read and write well enough to correspond with the persons of influence in his case. Ability in these lines began immediately to sprout. He did not even require an expert's guidance to learn to read and write.

"Another case grew out of a conflict which had its genesis in the over-anxiety of a mother. Greatly concerned about the child's mental development and eager to get the child to read before starting her to school, the mother at first urged and pleaded, and, these failing, later tried insistence and trickery to achieve her purpose. The child, at first merely bored, at length became obstinate in the contest with her mother. In this contest the pupil won; no incentive or contrivance would induce her to learn to read. She pleaded inability and perhaps in time believed in her own contention. A change of attitude on the part of the mother to indifference toward reading or even pretended satisfaction in the child's failure so reversed the effect of the disability that the child proceeded to learn, an achievement realized without unusual difficulty."

Not all difficulties in reading are caused in such ways. Some are due to unfortunate techniques developed early in the work. But even in these cases, as in those just given, the diagnostic program should include the same general steps. Diagnosis should embrace (1) a careful history of the case; (2) an analysis of the motives involved; (3) a study of the pupil's techniques, vision, intelligence and other factors involved. Remedial treatment should involve: (1) a rearrangement of the environment such that the motives favor, rather than oppose, learning to read; (2) explanations and encouragement designed to create the pupil's desire to learn and confidence that he can learn; (3) specific instruction, guidance and experience by methods suited to the difficulties, limitations and needs of that particular pupil; and (4) continuation of treatment until the old, inhibiting reactions are thoroughly supplanted by the new, appropriate ones. This general outline is applicable to practically all forms of maladjustment whether trivial ones in handwriting to supremely important ones in social, vocational, recreational or other realms of experience.

PREVENTIVE MEASURES

In all fields of service to humanity, prevention is preferred to cure, education to reëducation. How shall we avoid developing undesirable habits which reduce both happiness and usefulness? One thing we may do is to become familiar with the ways that are futile or destructive on the one hand and constructive on the other. We should, then, understand as well as we may the tendencies to idle dreaming, self-pity, rationalization, etc., not only in general, but also our particular susceptibilities and the conditions under which undesirable reactions are most likely to occur. We should understand the nature and relative strengths of our different urges and the ways in which they may be realized in a manner satisfying to us and to society alike. We should know our particular aptitudes and inaptitudes for the various activities and skills, intellectual and mechanical, social and individual, vocational and recreational, by means of which we may live most fully under normal conditions or effect adjustments during periods of privation.

Mere knowledge of what not to do; indeed, mere knowledge of just what to do, is insufficient. We must acquire the interests and skills which best suit our equipment of capacities; we must form the habits of holding our mental adjustments within proper limits, of thinking impersonally, of compensating wisely.

The "moral" of this discussion is contained in a quotation from William James's famous chapter on "Habit"; "The hell to be endured hereafter, of which theology tells, is no worse than the hell we make for ourselves in this world by habitually fashioning our characters in the wrong way. . . . The great thing, then, . . . is to make our nervous systems our ally instead of our enemy. . . . We must make automatic and habitual, as early as possible, as many useful actions as we can, and guard against the growing into ways that are likely to be disadvantageous to us, as we should guard against the plague."

The principles underlying several of the suggestions offered bluntly in these concluding paragraphs will be elaborated, and we hope, illuminated, in the chapters which follow. In the next few chapters we shall treat, in some detail, the principles of learning and habit formation.

QUESTIONS AND EXERCISES

1. What characteristic human desires are frequently thwarted and what adjustments are often made by the following:

The deaf child
The crippled child
The lighthouse keeper
The missionary
The slave
The youngest child in a household
The grandmother in a household
The head of a large business concern
The office boy
The book agent

2. Were the conditions of life under which primitive man lived more or less conducive to mental health than those of modern times?

3. What are some of the signs by which you can discover which individuals are prone to face reality and which to substitute mental adjustments to difficulties?

4. An experienced abnormal psychologist wrote that "sympathy blesses neither him that gives nor him that receives." Discuss the validity of this idea in the light of the facts presented in the chapter.

5. Explain, in scientific terms, the subconscious.

6. Who is the best judge of whether an individual is rationalizing or reasoning, the subject himself or an observer? What circumstances make different answers to this question possible?

7. Show that the mechanism of rationalization is useful in social intercourse.

8. Give five historical examples of individuals who compensated in a useful way for the thwarting of strong desires.

9. What mechanism is often behind the use of such terms as "bookworm," "grind," "profiteer" and the "reformer"?

10. Give as many examples as you can of "sour grapes," "projection" and other forms of adjustment. Which do you consider desirable? Which undesirable?

11. We say that a man, who resists the prompting of a strong urge because it is contrary to the social code, has a "strong will." What do we mean here by the term "will"?

12. A number of authorities have asserted that many "reformers" are motivated by impulses to protect themselves from danger or

temptation and that many of the most violent critics are subjects of "feelings of inferiority." Can you develop these notions more fully? Then evaluate their merits and deficiencies.

13. List some of the possible causes of eye trouble which prevent the completion of a required task in school.

14. To what mechanism might the normal individual attribute the activities of martyrs and what could easily be the martyr's reply?

15. Can you cite and explain any examples of "difficulties" similar to reading "disability" cases given in the text?

16. Make a list of the excuses frequently given by students failing to pass an examination and examine them for rationalization.

17. Draw up plans for:
   (a) A society in which conflicts due to social taboos would be reduced to a minimum;
   (b) An environment in which conflicts due to physical factors would be reduced to a minimum;
   (c) An organism with no conflicting impulses. How practical are your suggestions?

18. What is the best thing to do when a desire is thwarted? Is there any one adjustment that is always best for anyone? For every one?

19. Recall instances of unusual but probably not genuine cures. Explain them. Apply to the usual attitude of people toward cures, the well-known fallacy, "Post hoc ergo propter hoc" (after, therefore because of).

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CHAPTER VIII

LAWS OF LEARNING

In the preceding chapters, several facts were observed which bear upon the nature of learning. In the discussion of the connecting mechanism we noted the tremendous complexity of neurones, particularly those in the brain, which are concerned in learning. We observed that, between sense organs and reacting mechanisms were series of neural connections offering innumerable possible pathways but that the nerve impulse usually takes some limited course. The limiting conditions were found in the synaptic connections, some of which were "open," some of which were "closed." To acquire new reactions means to change these conditions at the synapses, to change the effective connections. In a later chapter we noted the fact that such neural changes are possible, as a result of our original nature. For this reason, it was said that the capacity to learn is a native trait. In the last two chapters were given illustrations of some of the dynamic factors in learning, with special emphasis on the rôle of certain prominent cravings in initiating and subtly controlling learning. The importance of proper habit formation was also stressed. Learning and habit formation is adjustment to the conditions of life. We strive to avoid the annoying and to achieve the satisfying states of affairs, and in thus striving we learn; but what annoy and what satisfy are largely determined by a number of native and acquired cravings. This does not mean that the habits we form are specifically predetermined by our natures. On the contrary, many habits, both good and bad, may satisfy our cravings and what is more, our main urges may be modified within limits, by proper training. The present chapter serves as an introduction to the principles to be observed in the task of training one's self or others. First will be presented certain very general laws of learning, principles which hold for every type of acquisition. These will be illustrated anew as we proceed to more detailed considerations and to particular rules of economy in learning.

We Learn by Reacting.—Of prime importance is the first generalization, namely, that we learn by reacting. Learning takes place only during activity; it is never a passive process of absorption, but on the contrary, a very active process of reacting. Acquisitions of the observational or informational type, such as becoming familiar with a face, tree or building so that we can later recognize or recall it, or memorizing names and dates, the spelling of a word, or acquiring information during reading, like the acquisitions of movements and skills, are the result of reactivities. The same is true of learning to control one's temper, or to appreciate music, art or literature; all these are acquired in the process of reacting. In fact, what one learns are reactions; namely, those reactions which, having once been made, are strengthened during further responses.

The Law of Use

The simplest form of learning consists in the strengthening of native reactions. Exercise of any reaction—walking, grasping, crying, laughing, becoming angry, sad, or joyous—other things being equal, tends to make that reaction more prompt, more certain, more easy. The use or exercise of any situation-response connection strengthens it; the stronger the connection the more prompt, easy and certain the response. The use of a connection unit (series of neurones) brings about certain changes, possibly in the synapses, which makes the passage of the nerve impulse more rapid, easy and complete. This is what is meant by increasing the strength of the connection between a stimulus and a response. Such modifiability of nervous structure is a native capacity which may be expressed by the *Law of Modification by Exercise*, or more simply, the *Law of Use*. It may be stated as follows: *Whenever a modifiable connection between a situation and a response is exercised, other things being equal, the strength of that connection is increased.*

The Law of Frequency.—The Law of Use expresses a basal fact, one that is needed to explain learning of every kind. A necessary correlate of this law is the fact that exercise up to a certain physiological limit is cumulative in effect. If one response strengthens the connection somewhat, then two responses have greater effect than one, three greater than two and so on. *Consequently, other things being equal, the more frequently a connection has been exercised the stronger the connection.* This is sometimes called the *Law of Frequency.*

THE LAW OF DISUSE

Modifications in the nervous system produced by use, however, are not retained in completeness for unlimited time. The nervous changes brought about by disuse are, roughly speaking, comparable to those produced in a muscle. One may by exercise strengthen the muscle to a high degree of vigor, but the effects gradually disappear with disuse. The gradual forgetting of names, dates, or poetry, the gradual loss of skill in typewriting, drawing, singing, etc., when these functions are not revived by exercise, illustrate this fact. The *Law of Disuse* takes a place with the Law of Use as a well established principle. It may be stated as follows: *When a modifiable connection between a situation and a response is not exercised during a length of time, the strength of the connection is decreased.*

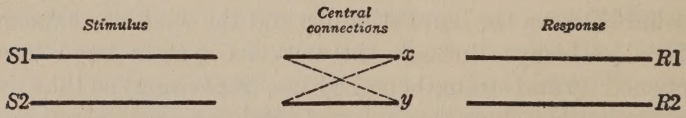
The Law of Recency.—The deterioration of connections through disuse is a gradual process. One day of disuse causes some loss in the strength of a connection, two days a little more, and so on. The effect is cumulative, a fact often expressed in the correlative *Law of Recency*, which may be stated thus: *Other things being equal, the more recent the exercise, the stronger the connection between the situation and response.*

THE PRINCIPLE OF SIMULTANEOUS STIMULATION IN THE FORMATION OF NEW CONNECTIONS

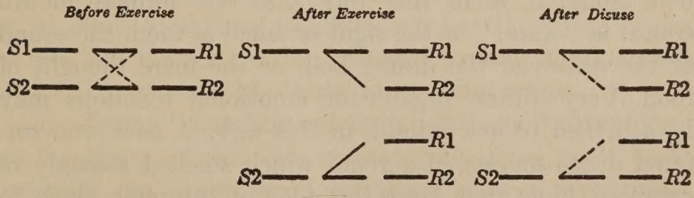
While the strengthening effect of use is involved in all learning (the weakening effects of disuse being really a passive process), the acquisition of all complex functions such as writing, speech, swimming, reading, learning poetry, involves a great deal more than mere repetition of a number of native reactions. It involves the addition and elimination of constituent connections and the constant reorganization of reactions into new combinations. We do not learn to write by merely repeating the same activity which was adopted on our first attempt to write. We begin with one combination of reactions which continually changes, during further practice, by elimination of some of the older component reactions and the addition of other new ones and the constant recombination of those activities present at each moment of practice. We must, therefore, explain how S–R connections are added, eliminated and combined into new total patterns.

New connections are established when two (or more) situations which elicit different but not mutually exclusive reactions are repeatedly presented simultaneously. When an object moves rapidly toward the eye, the native reaction is a wink; when the skin of the finger is stimulated with a slight electric shock the native response is a quick withdrawal of the hand. If the two stimuli are given at once the result is a simultaneous wink and jerk of the hand. If we continue, time after time, to give the two stimuli at once and finally give only one—say the electric shock—the probable result is that both the jerk of the hand and the wink will occur at once. Or, if we move the object rapidly toward the eye, both wink and jerk will occur. Here, then, is a clear case of acquisition; we now have a combination of two responses to a situation which previously gave us only one. Or, to say the same thing in another way, we have acquired new connections: one between the eye stimulus and the hand effectors, and another between the hand stimulus and the wink mechanism. New pathways through the nervous system have been opened up and strengthened by use (repetition) so that the nerve impulse flows through and produces a new reaction.

The Neural Basis of Learning.—A significant feature of the nervous system is that it provides pathways from each receptor to a tremendous number, probably to all effectors (see pp. 57–60). Of these innumerable connections but few are strong enough to arouse the effectors as the result of ordinary stimulation; the others are "closed" in the sense of usually producing no observable reaction. Actually, then, physical connections between the eye stimulus and the hand muscles, as well as between the hand stimulus and the eyelid muscles must have been in existence to begin with. Let us call the stimulus, movement of the object toward the eye, S1, and the wink R1; the electric shock S2 and the withdrawal of the hand R2. The connections are pictured in the figure below. The heavy line indicates a strong connection, the dash line a weak connection. Although S1 is actually connected with R2 it cannot alone arouse R2 because the intervening pathway (mainly the synapses at y) offers too much resistance. When S2 is stimulated at the same time, the barriers at y are broken down so that the impulse from S1 gets through, discharging weakly at first, into R2, according to the principle of facilitation (see Chapter II). By repetition of this combined stimulation, the impulse from S1, according to the Law of Use, would break through more and more readily. In other words, the connection between S1 and R2 is gradually strengthened by use until S1 alone is capable of producing the response R2 as well as its original, R1. All of this is true of the S2–R1 connection also.



Characteristics of Acquired Joint Reactions.—By the repeated presentation of two situations which produce two harmonious (in the sense that both can occur at once) reactions, each stimulus becomes connected with both responses. To each has been attached a new reaction, in addition to the old one. The object-approaching-the-eye produces a jerk of the hand; the shock produces a wink. Neither of these was made, until the "subliminal" connection (a connection too weak to elicit an actual response) had been strengthened by the combined exercise. Thereafter, either situation produces both responses; and according to the Law of Use, continually to administer one stimulus would further increase the strength of both connections, so that the combined response would occur more surely, promptly and easily. This raises the question as to whether both combinations are identical. No, they are not; for the reason that the connection of each stimulus with its old response always remains stronger. The object-approach-eye stimulus invariably produces a combination in which the wink is more emphatic; the finger shock produces a combination in which the finger jerk is more pronounced. While the reactions in both cases include both wink and finger jerk, it is necessary to think of them as a *joint reaction* determined by the strength of the particular connections between the specific stimuli and the specific responses. The justification for this is seen most clearly if you fail to exercise one of the joint reactions for a while. Fail to apply the shock stimulus for a time and the wink unit of the combination may fail to occur,—it has died out from disuse,—whereas the withdrawal of the hand, being more strongly connected with the stimulus, still occurs.



The facts are shown diagrammatically in the figure above. In the figure, the heavier the line the stronger is the connection. The dotted line means a subliminal connection.

Simultaneous Stimulation in the Acquisition of Motor Reactions.—When a hungry kitten sees food it will run toward it. If a child displays food, at the same time calling

"Kitty, kitty," a sufficient number of times, the kitten will eventually respond to the call alone. When we are breaking a horse, it does not, of course, respond in any way except by pricking up its ears when we say "Whoa." We stop the horse by pulling on the bit and if, at the same time, we shout "Whoa," and repeat sufficiently, the horse will stop eventually at the word. In both of these cases new connections have been acquired. In both cases, the old response to "Kitty, kitty" or to "Whoa" was mainly an awareness of the sound with but little motor response. These responses still persist but occur simultaneously with the new reactions, *i.e.*, running toward the call or stopping at "Whoa."

Simultaneous Stimulation in the Acquisition of Emotional Reactions.—Connections with glandular reactions, as well as with motor reactions, may be acquired in this way. To the stimulus, food in the mouth, a dog responds by secretion of saliva. If at the time food is presented a bell is rung, the animal will, after sufficient trials, respond by the salivary reaction to the bell alone. It is in this way that the human mouth comes to "water" at the sight or smell of food, the sound of the dishes or the dinner bell, or the mere thought of food. Very diffuse organic or emotional reactions may be attached to new stimuli in this way. A man who suffered acute nausea in a room which smelled strongly of camphor finds that later the odor of camphor tends to reinstate the sickness. After a long voyage, during which one has been seasick, the smell of ship or sea or the mere thought of them may turn one's stomach in some degree. Similarly tears, mirth, affection or minor likes and dislikes may secure new attachments. In these instances, the reaction produced by the newly attached stimulus is not identical with the response produced by the original stimulus. It is merely a weakly aroused reaction of the same sort; weakly aroused since it would require a great deal of exercise to make the new connection as strong as the old.

Simultaneous Stimulation in Informational Learning.—Certain types of information are acquired by attachments of this sort. When shown a leaf, the child reacts by becoming aware of the object. If, while showing the object, one says the word "leaf" and repeats this simultaneous stimulation a number of times, the child will come to think of the object when he hears the word alone. Thus he learns the meaning of the spoken word; for the word itself is merely a combination of auditory stimuli not in the least like the visual appearance of a leaf. Next, we may show the object (or say "leaf") while the child looks at the printed word **leaf**. With sufficient combined repetition, the child will learn to think of the object when he sees the printed word. Later the object, a picture of the object, the spoken, written, or printed word, may be coupled with the French words "la feuille" and the two together reacted to until he thinks of the object or, at least, something which stands for the object, when he sees the French words. All such learning is accounted for by the principle of simultaneous stimulation.

The Terms "Conditioned Reaction" and "Conditioning."—Many of the illustrations just given have been described as "conditioned reactions" and the processes of developing them by presenting simultaneously two situations which lead to different reactions has been called "conditioning." The term "conditioning" was introduced by a famous Russian scientist, Pavlov, who first described the case of "conditioning" the salivary reflex by presenting its stimulus, the taste of food, simultaneously with the sound of a bell. The same terms have been used extensively by John Watson and other "behaviorists" in this country. There is one objection to the use of these terms. It is that Watson and others have applied to them incomplete description of the whole process of forming and eliminating connections by simultaneously presenting two stimuli. They tell only half of the story. In describing the dog-salivary case they speak as if the salivary reaction were merely attached to the bell stimulus, forgetting that the bell stimulus provoked its response, pricking up the ears, which is also attached to the food stimulus. While it does not seem to matter practically in this case whether the bell stimulus did or did not cause a response, it matters greatly in some cases, as we shall presently see. It matters greatly whether the two reactions made to the two stimuli are capable of happening at once, and uniting into a joint response, or whether they are incompatible and contradictory. For this reason, which will become more significant as we go along, we prefer not to use the terms "conditioned response." We prefer to place the emphasis upon the application of the stimulus. This is really the important matter from the practical point of view. The principle of simultaneous stimulation covers all the cases described by conditioning and other important cases too. Some of the latter will now be taken up.

Simultaneous Presentation of Situations in Perception.—In actual life, the simultaneous stimuli are not invariably limited to two; indeed, the usual case includes many more, but the principle is the same. It is by the combination of many reactions, for example, that percepts are built up. When a child is first given an apple he makes many reactions to the many stimuli which the fruit provides. He becomes aware of its odor, of its shape, its weight, its taste, etc., by responding to the several olfactory, visual and other stimuli, simultaneously or in immediate succession. The several responses become attached to each of the several stimuli and with frequent repetition of the experiences one stimulus alone may activate simultaneously, to some degree, the several reactions. The apple is thus perceived when only seen or smelled or felt. We become at once aware of it as a combination of such and such tastes, odors, shape, weight, uses, cost, etc. An apple perceived through the sense of touch is not exactly the same as the percept of an apple smelled, tasted or seen. But the perceptual reaction is so quick, and our interest in it so practical, generally, that, aside from the differences in the component sensory qualities—color in one case, odor in another, etc.—we do not realize the distinctions. Each perceptual reaction is, as the exponents of *Gestalt* psychology say, a unified or integrated configuration, but it is, as we see it, an integration which develops and changes with alterations, additions and subtractions, of parts.

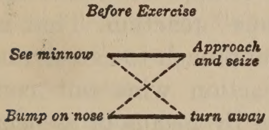
General Conclusions.—The samples of learning so far considered are, of course, acquired by use, once the possibility of the exercise of the new connection is established. The interconnections in the nervous system make possible limitless additions of connections; all that is needed, apparently, is simultaneous presentation and exercise. If we can attach the wink reaction to a stimulus on the finger or the salivary reaction to the sound of a bell, it would appear that we can attach any stimulus to any response. So we may generalize: *By means of repeated simultaneous presentation of stimuli any reaction which the organism can make may be attached to any situation to which the organism is sensitive.* This is the general principle of simultaneous stimulation.

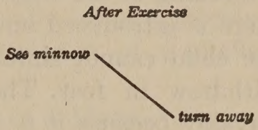
This is an important generalization; but should it be called a law and be put on a par with the Law of Use or Disuse? If we examine the facts closely it will appear that exercise is really doing the work. From the start there existed real but weak (subliminal) connections which were strengthened when the proper combination of the stimuli was provided. We have merely described the results of the operation of the Law of Use under certain conditions; namely, when two (or more) situations leading to different but not mutually exclusive reactions are repeatedly presented together.

THE PRINCIPLE OF SIMULTANEOUS STIMULATION IN THE ELIMINATION OF CONNECTIONS

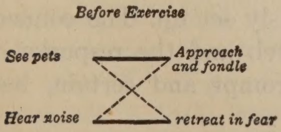
Learning does not consist entirely of the strengthening and consequent addition of effective connections. Weakening and elimination of connections already present is quite as important. A reaction may be eliminated by the simultaneous presentation of two (or more) stimuli which lead to mutually exclusive reactions.

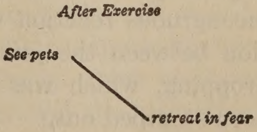
An Experiment with a Perch.—A minnow thrown into an aquarium with a hungry perch will be very promptly seized, since the former acts as a stimulus to one of the strongest of the latter's native food-getting reactions. If a glass partition is placed so as to divide the aquarium into halves, the perch in attempting to seize a minnow thrown into the opposite compartment bumps into the transparent obstruction. On receiving the bump, the big fish turns about and swims to the edge of its compartment. Shortly, it darts at the minnow again only to be halted by the same punishment. It will suffer a good many bumps on the first day before giving up entirely, but on the next day fewer bumps are effective; and so on, until after about thirty days, instead of attacking, the perch swims off to the side or engages in other activity. The attack reaction has been, temporarily at least, eliminated. The bump not only blocked the old reaction but set up a turn-about-and-swim-away reaction which by simultaneous association became attached to the old stimulus. When the perch now sees a minnow, the nerve impulse is shifted into the turn-away reaction. These facts are illustrated in the accompanying diagram.


Before Exercise
See minnow
Approach and seize
Bump on nose
turn away


After Exercise
See minnow
turn away

An Experiment with an Infant.—An infant while playing with some pets, which it fondled with pleasure, was frightened by a crashing noise. The child, of course, could not fondle the pets and at the same time withdraw in fear. The fear reaction, getting the right of way, put a stop to the caressing of the animal. The interesting thing about this case was that later when the child saw one of the pets he no longer approached it with pleasure but retreated in fear. This was not a combination of two reactions, but a selection of one reaction and elimination of the other. The nerve impulse aroused by the sight of the animal has been shifted from its old course into another. The fear has been substituted for the fondling reaction. So far as the principle of simultaneous stimulation is concerned, this case is quite like the previous one, as shown in the accompanying diagram.


Before Exercise
See pets
Approach and fondle
Hear noise
retreat in fear


After Exercise
See pets
retreat in fear

The elimination of the attack on the minnow by the perch might be explained by the simultaneous introduction of a stimulus (the bump from the glass partition) which proves an effective block and which also sets up a mutually exclusive or "incongruous" reaction—the turn-away. In the case of the child who acquired a fear-and-retreat reaction on sight of the animals, there is scarcely a blocking of the original response of approach, although there is introduced an "incongruous" reaction. That is, the child cannot simultaneously approach-to-caress and withdraw in fear. The latter reaction wins out conceivably because it is stronger and by means of association becomes attached to the stimulus which originally led to the incompatible response of approaching-to-fondle.

Elimination without a Blocking.—Responses are eliminated, however, when no *external* blockage, or obstruction is obviously present to set up an incongruous reaction. A famous experiment, performed upon spiders, will serve as an illustration. It was found that a spider descended hurriedly into its web when the web was jerked gently. When the insect had climbed back, a repetition of the stimulus produced the same reaction; but after eight or nine trials the stimulus suddenly lost its power; the spider failed to react by descending into the web. Next day, however, the stimulus was effective for a time but failed after six or seven repetitions, and after about ten days the dropping reaction ceased entirely—at least for a time. In this experiment the spider's reaction was not physically blocked; no pain was involved; no definite incongruous reaction was obviously set up. The connection between the jerks of the web and the response of dropping, which was at first prompt and certain, had been stamped out.

THE LAW OF EFFECT

This is really a most curious matter. It looks as if dropping-to-the-ground reaction had been eliminated in the very process of exercise. According to the Law of Use, the tendency to drop at the sound of the tuning fork should have been strengthened; should have become more prompt and certain. Instead of that, it gradually became less prompt and certain, finally being eliminated entirely. Let us give another illustration of a similar phenomenon.

Illustration from Study of Rats in a Maze.—For one investigation, a box was constructed in such a way as to offer to a rat placed in a certain compartment four different avenues of escape, all of which led to food. The box is pictured in Figure 22. One way led through a small compartment in which the rat always received a slight electric shock as he passed; a second led to a similar compartment, in which the rat was confined for twenty seconds before being permitted to proceed; a third led to a long pathway to be traversed before food was reached; and the fourth compartment provided a short pathway directly to the food. The positions of the four little compartments were so arranged that a particular rat, on his first trial, was as likely to enter one as another; so, by using a number of rats, it was possible to ascertain the factors which guided choice. Each of thirteen rats was given trials until it had finally selected and thoroughly learned one of the four ways.

At first, a rat was as likely to take one way as another, with the result that in the first four trials each way to the food was practiced equally often, approximately. But soon all had given up the pathway which produced the shock. A little later all had refused the way which produced the twenty seconds of confinement. The long way was eliminated more slowly; but finally all but two went by the short route. Now, by the Law of Use alone, it would seem that an equal number should have learned permanently to go by each route, since each was chosen and exercised equally often at the beginning. But the fact was that the exercise which brought pain failed to be effective; the rats soon gave up that route. Practice of the route which brought confinement was more effective; but finally that route was eliminated by the whole group. Use of the roundabout pathway was likewise insufficiently

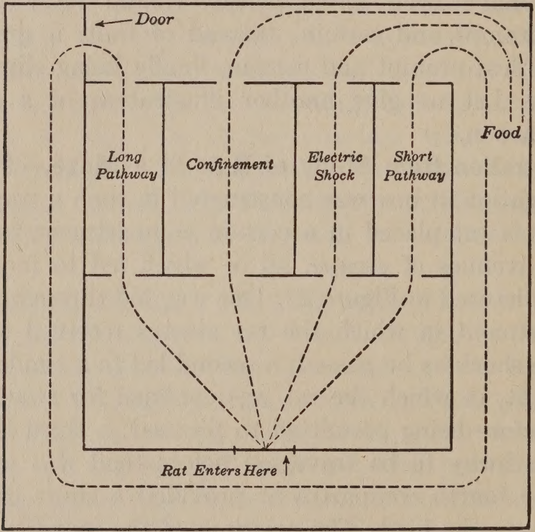


Fig. 22.—The Experimental Compartment Box Showing the Several Routes. In the actual experiment the compartments were rearranged for different groups of rats, *i.e.*, for one group "confinement" would be situated on the left, for another in the second position, as pictured above, for another in the third position, and for another on the right. Thus no type of "effect" was given the conceivable advantage of a favorable position. Movable doors were also provided to force the rat in the direction desired after emerging from the compartment. (After Kuo, *Journal of Comparative Psychology*, Feb., 1922.)

effective, since with the exception of two rats all gave it up, although they relinquished this pathway less promptly than they did the first two routes.

Illustration from Behavior of Cats.—Another illustration, similar in principle, may be more clear. Suppose that after five cats have been taught to come to the call of "Kitty, Kitty," each is called singly, and No. 1 is given food and later caressed, No. 2 is caressed only, No. 3 is totally disregarded, No. 4 is sprinkled gently with water, and No. 5 is doused with water. Assuming that all have just learned to respond to the call and that other conditions such as hunger, fatigue, the satisfaction occasioned by the activity under way at the time called, etc., are approximately equal, they should all learn to come more promptly and surely by virtue of exercise, as they are repeatedly called. But will they? Cat No. 1, which was fed and petted, will probably come more and more surely and promptly; No. 2, which was merely petted, will probably continue to come but not so promptly as No. 1; No. 3, which was entirely disregarded, will probably continue to respond for a while, but less promptly and frequently, finally failing altogether; No. 4, which was sprinkled, will probably give it up more quickly than No. 3; and No. 5, which was doused, will probably very promptly show a failure to respond.

The Influence of the Effect of a Reaction.—Certainly it looks as if influences other than exercise and simultaneous presentation of stimuli, are at work here. Very potent influences they must be to nullify and augment the results of exercises as they seem to do in the illustrations just given. It looks as if there were something in the *effect* of a reaction as a whole which either reinforces or decreases the results of use or causes an animal to repeat the act in one case and avoid it in the other. Reactions which result in pain, confinement, the holding up of a tendency under way, futile or wasteful work, all tend to give way to reactions which are more satisfying or less annoying. On the other hand, reactions which bring release from confinement or pain, which bring food, kindly treatment or attention, are repeated and stamped in. It is the reaction which gratifies some strong urge, which brings a satisfying state of affairs, absolute or relative, that is selected and learned quickly during use. The more satisfying the resulting general state the more surely the reaction will be repeated and the more quickly it will be mastered.

An infant lying in its crib is disregarded by its mother and her guest. Soon the child begins to cry and scream. The women rush to the baby, pick it up, fondle and pet it. Treatment highly satisfying to the child is thus associated with crying and screaming. Similar experiences follow on many occasions, and when the child has attained several years of age it may still set up a great racket if it is disregarded or uncomfortable. The tendency to cry and scream in such situations appears to have been built up by the satisfying effects of attention which it had always brought. One child, aged eight, had developed a habit of persistent "begging" when its mother said "No" to its requests, whereas a neighboring child of the same age took "No" as final without further whimpering. Both children had in earlier years repeated their demands after the first "No," but the mother of the first child, perhaps to avoid being bothered, frequently gave consent sooner or later, whereas the other mother did not change her decision. A child learned to use a "naughty" word on the street because it was taught and applauded by some "nice big boys," but its use at home was stamped out because it brought a scolding, or perhaps better, total disregard. Attach to any response a stimulus which satisfies a craving and it will be learned; attach one which thwarts a craving and it will drop out.

The "Law of Effect."—Such facts as these seem to indicate that the Law of Exercise alone is insufficient to illuminate all cases of learning. Such facts as these seem to call for a companion principle. A companion principle was offered about 1900 by Thorndike. It was called the "Law of Effect." The following is one way of stating this formulation: *Individuals tend to repeat those reactions which, on the whole, are satisfying, whereas they tend to avoid, and therefore to fail to repeat, those reactions which, on the whole, are annoying.*

EXPLANATION OF THE LAW OF EFFECT IN ACCORDANCE WITH THE PRINCIPLE OF SIMULTANEOUS STIMULATION

It should be noted that the Law of Effect states that certain types of reactions, namely those which are, on the whole, satisfying, will be repeated and consequently learned. It states that reactions which are annoying, on the whole, will be avoided, therefore not repeated and consequently not learned. Few students of psychology would deny these general facts, but there is much dispute concerning the more ultimate explanation of the facts.

An Explanation of Effect in Terms of Neural Conditions.—Thorndike, who originated the term Law of Effect during his pioneer work on animal learning, was inclined to believe that "satisfyingness" and "annoyingness" were intimately associated with the subtle changes in the neurones themselves, which in one case intensify or further the effects of exercise and in the other reduce or nullify them. These hypotheses are contained in the following quotation: "When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, its strength is increased: when made and accompanied or followed by an annoying state of affairs, its strength is decreased." That is to say: The effects of exercise influence the neurones in the one case in a way favorable to strengthening the connections and in the other case in a way to weaken the connections. The difficulty with this assumption is the lack of information concerning the character of the neural changes correlated with satisfaction on the one hand and annoyingness on the other.

An Explanation in Terms of Simultaneous Stimulation.—The facts covered by the Law of Effect can be explained in another way. They can be explained in terms of simultaneous presentation of two or more situations such as we have illustrated above. It is merely necessary to observe in these cases that while the person or animal is reacting to one stimulus another stimulus is supplied which leads to a different response which is so decidedly satisfying (or annoying) as to make the reaction "on the whole" satisfying (or annoying). Take the case of the cats. The first stimulus is the call "Kitty, Kitty!" As a response to this stimulus the cat runs to the experimenter. Now while still calling "Kitty, Kitty" the experimenter applies another stimulus, a bowl of milk. To the bowl of milk the cat responds by the satisfying reaction of drinking. Now consider cat No. 5. While calling "Kitty, Kitty," as the cat comes near, the experimenter applies another stimulus—a dash of cold water. The latter stimulus sets up the negative reaction of withdrawing in annoyance. This reaction becomes attached to the simultaneous stimulus "Kitty, Kitty." Later the call alone tends to produce an annoyance and withdrawal. Take cat No. 3 which was disregarded. While calling "Kitty, Kitty," the experimenter, instead of giving food as before, offers simultaneously the stimulus "disregarding behavior." An unaccustomed disregarding behavior on the part of the experimenter tends to produce the response "do nothing" on the part of the cat. This response tends, of course, to be connected with the call of "Kitty, Kitty," so that later when the call alone is heard the cat responds by "doing nothing"—except being annoyed. Since the response to "disregard" is less emphatic and less annoying than the reaction to "being doused with water" it tends to be connected less firmly and quickly with "Kitty, Kitty."

Now take the case of the spider. The first stimulus, a jerking of the web, had in the spider's previous experience occurred together with "seeing a fly" to which the spider responded by scurrying down to its web to enjoy a dinner. Later the jerking of the web alone produced the dash into the web. But when the experimenter entered, the jerking of the web occurred not simultaneously with *presence of a fly* but with the simultaneous situation "*nothing but an empty web.*" To the situation "nothing but an empty web" the spider's customary response is to "do nothing" or "stand pat." What the experimenter did, then, was to present repeatedly along with a "jerking of the web" a new stimulus "nothing but an empty web" until the response to the latter stimulus, namely, "do nothing" became more closely connected with the original stimulus, the jerking, than the "running down" which was previously connected with it. Thus it appears on close examination that all of these are really cases of simultaneous presentation of two or more stimuli. In all these instances one response proves to be the stronger; it is prepotent and in the course of time the prepotent response becomes attached to both stimuli. The more prepotent the response is, the more surely and quickly it becomes the reaction to both situations. These cases, then, are not really exceptions to the Law of Exercise but merely illustrations of its operation in complex cases in which different stimuli simultaneously presented lead to different types of response.

One Situation May Include Two or More Stimuli Occurring Simultaneously.—It is important to observe that in many cases of learning one thing, event or situation may be responsible for two or more stimuli. Take the familiar example of the child who learns to avoid exposing his hand to a flame. First the child sees the flame; that is, he responds to a visual stimulus. The flame is an attractive visual object to which the child reacts by approaching, extending his hand, and feeling pleased. The moment his hand comes in contact with the flame, another stimulus becomes effective, namely, extreme heat. The flame, then, is really two stimuli; it is a visual stimulus to the eye provoking a satisfying inner response and actual approach; but also a thermal stimulus to the hand producing annoyance and quick withdrawal. Note, too, that both occur together, or nearly enough together to make them a case of simultaneous stimulation. The child was probably seeing the flame when he touched it, or at least, he looked immediately after touching it. In this case the annoying, withdrawing response is prepotent over the more mild, pleasing, approach response and later the mere sight of the flame leads not to happy approach but to annoyance and withdrawal. The latter response to the sight of the flame will, on repetition, usually become reduced to a mere twinge of annoyance and a mere keeping at a distance instead of terrific annoyance and complete withdrawal. These reductions are due, however, to other experiences which come in later; experiences which, if outlined, would reveal the same processes of simultaneous stimulation.

The Rôle of Effect in Simultaneous Stimulation.—If these cases can be explained by exercise, when two stimuli leading to different responses are simultaneously presented, is not the Law of Effect superfluous? At first sight it does seem so. But wait. These cases can be explained only when you show that one response is *prepotent.* Now avoiding reactions are prepotent over rather indifferent reactions; and the avoiding reaction, as we saw in Chapter IV, goes along with annoyance or unpleasantness. On the other hand, the accepting, go-ahead reactions are prepotent over indifferent reactions; and the positive, accepting responses go hand in hand with general, organic satisfaction. Now, what are the vital matters but these *effects?* The whole question is: What *effect* will be produced by the new stimulus one is about to apply? What will be the *effect* of presenting along with the call "Kitty, Kitty" such a stimulus as—a slap on the ear, a piece of fish, or rubbing the fur the wrong way? What will happen to the old stimulus depends entirely on the effect of the new one. So it appears that the matter of effect is of vital importance. It is so important that such a statement as that which comprises the "Law of Effect" becomes a practical guide of primary value.

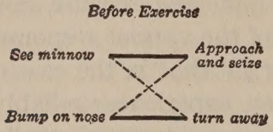
The Combined Operation of Exercise and Effect during Simultaneous Stimulation.—In dealing with any learning problem, then, there are three facts to keep in mind. First, one must remember that nothing is learned without *exercise.* A response cannot be acquired unless it is made. Even if making a response once ties it up to a stimulus, exercise has been at work since to make a reaction once is to give exercise to that stimulus-response unit. The Law of Exercise, therefore, is sound and indispensable. Second, one must remember that a new connection can be made only when two or more stimuli are presented together. Conversely, whenever a marked change in a response to a given stimulus occurs, you may be sure it was brought about by the simultaneous occurrence of some other stimulus with the first one. The question a teacher or animal trainer must always ask, then, is "What stimuli are now acting simultaneously?" or "What *new* stimulus am I permitting to act in this situation?" Thirdly, one must ask: "What will be the *effect* of any new stimulus that may appear or be purposely introduced?" The last question is of primary importance because its answer will determine what reaction will eventually emerge and become attached to the stimuli that were presented together. One must always ask one's-self: "What stimuli am I presenting together? What will be the effects of each stimulus? How much exercise am I providing or must I provide?" You can cover all phases of the learning process only by considering the exercise and effects of reactions set up together. Neither the principle of exercise, nor of simultaneous presentation, nor of effect *alone* will explain learning or enable you to predict what will be learned. All three principles must be taken into account.

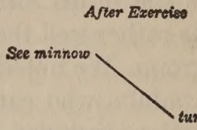
Use of the Terms Satisfying and Annoying.—The statement of the Law of Effect must be considered further. The statement may be slightly modified as follows: *Individuals tend to repeat and consequently to learn, those reactions, which, on the whole are satisfying, whereas they tend not to repeat, and consequently not to learn, those reactions which on the whole are annoying.* The terms *satisfying* and *annoying* are used merely as suggestive guides to two types of adjustments into which, as we observed in Chapter IV, most human reactions can be grouped. The one group refers to positive, accepting adjustments, the other to negative, neglecting or avoiding reactions.

Within each group are innumerable particular reactions differing in details, but alike in that all in one category are *positive*, and all in the other are *negative* adjustments. We use the terms *satisfying* and *annoying* because each suggests rather well the character of the various responses in its group. We noted in Chapter IV that in the case of human adults who can report their experiences reliably, the reactions included in the satisfying group are usually, if not invariably, reported as accompanied (or followed at an imperceptible interval) by the feeling of pleasantness and reactions in the annoying group by unpleasantness. Now, while we cannot discover whether animals and infants experience similar feelings, it seems highly probable that they do. Whether this guess is correct or not is a matter of no importance to our theory of learning. We can apply the term satisfying to forms of observable behavior which possess the positive, acceptance character and annoying to those that show negative characteristics. The terms are, in fact, used for these purposes without necessarily implying the existence of the conscious experience of pleasantness and unpleasantness. These terms, in other words, refer to behavior observed in others rather than to experience limited to oneself.

APPLICATIONS OF THE LAWS OF LEARNING

Illustrated by the Perch Experiment.—A little more attention must be given to the matter of elimination of connections because it has some important implications for learning, particularly when we are dealing with very strong tendencies. Let us recall the experiment with the perch. When the perch received the bump on the nose he turned about and swam away. The annoying effect of the bump weakened the tendency to attack until finally, when the perch observed a minnow he turned away instead of attacking as before. The turn-away reaction has been substituted for attack, as shown in the accompanying diagram.


Before Exercise


After Exercise

What happens to the old reaction—that of attacking a minnow when it is seen? Since it is no longer being exercised, it is of course dying out, according to the Law of Disuse. But so strong a tendency as that of a fish to seize its food takes a long time to die out from mere disuse. Many acquired reactions, which are probably less deeply imbedded in our nervous systems, will scarcely die out from disuse in the course of a lifetime. If you could, by some miracle, refrain from saying, thinking, or otherwise using your name, how long would it be before recall would be impossible? Certainly a very long time, probably more than fifty years. So the perch's tendency to seize minnows is still in existence but, for the present, another reaction is taking its place, namely, the tendency to turn away—a reaction originally made to the bump on the nose but now made directly to the presence of the minnow. How long will this substitute reaction keep up? Just so long as it remains stronger than the other tendency. But actually in this experiment the perch gradually lost the turning-away reaction and went back to his old trick of seizing the minnows. Why? Because the substitute reaction, although exercised, produces no satisfying effect nor did an accidental lapse into an attack prove annoying. The old bump-on-the-nose stimulus no longer was acting. An attack now led to a meal and the old reaction assumed the right of way.

Illustrated by Human Behavior.—These facts may be illustrated by observation of human behavior. A child is natively self-assertive—so forward and boastful that the parent in an attempt to break his tendency demands, on each outbreak, that the child refrain from speaking for five minutes. After this has been done several times, the situation which previously elicited a boastful outbreak now tends to produce cautious remarks because of the effect of the earlier punishment. When the boastful outbreaks cease, of course, the punishments also cease, and as time goes on, the holding in of the impulse to boasting becomes annoying, until finally the old reaction breaks out again. One cure for it is further punishment; but there is another way of dealing with the situation, namely, by applying a stimulus which will make the substitute reaction satisfying.

If the perch, when it turned toward the side of the aquarium after the bump, had been given food and similarly rewarded on each succeeding instance, it would eventually, on seeing a minnow, promptly turn to the side where it was fed. If the child had been greatly satisfied by praise or some other reward stimulus whenever it refrained from unseemly self-assertion, the more modest reaction would have been gradually built up through exercise and effect where exercise alone might have failed. *Here then is the essence of eliminating undesirable tendencies; start the desirable substitute reaction by applying a stimulus which produces it, punishment if necessary, but build it up by making it satisfying.* You make a response satisfying on the whole of course by introducing stimuli which lead to satisfying reactions.

Forms of Satisfying and Annoying Influences.—Social disapproval, harmless deprivations, and other such stimuli may do as well as physical punishment. Any stimulus that will elicit the desired substitute reaction is what is needed. For example, in attempting to "break" the child of fear and crying during thunderstorms, scolding, threats, or other punishments only make matters worse. Show an interest in the lightning, call attention to its novelty and beauty and thus substitute for the undesirable reactions curious observation. When you get that, or some better substitute, reward it by praise. Praise of course is a stimulus. It is thus by the proper application of satisfying and annoying stimuli as well as by practice that the course of learning may be most effectively directed.

How Nearly Simultaneously Stimuli Must Be Presented to Affect Learning.—Our previous statements have been that two or more stimuli to influence learning must be presented simultaneously. A dog that had eaten forbidden food was discovered five minutes after the act and cuffed. It is highly improbable that the punishment would have any effect upon the dog's act of stealing food. The stimulus was probably associated with the dog's act of lying on the porch mat since this is what the dog was doing at the time. A child who had eaten forbidden jam was similarly discovered and cuffed five minutes after the act. How the second stimulus, the cuffing, would affect the child would depend somewhat on circumstances. The effect on a very young child would probably be like that on a dog; the stimulus would become associated with the wrong situation. An older child might be "told why" he was being cuffed, and the spoken words might serve adequately as a substitute for the stealing-food situation and consequently be effective. To be effective the punishing or rewarding stimulus must occur simultaneously with the situation which is to be affected by it. By simultaneously, we do not mean necessarily simultaneously to the point of a split-second. Most stimuli, even a snap or prick, in the most artificial experimental tests of simultaneous presentations are effective for a few seconds so that one can follow the other at a brief interval and still function in ways previously described. In the case of animals, this interval is very short. Probably the best general statement is that to "condition" a reaction R1 to a stimulus S1, the annoying (or satisfying) stimulus S2 must be presented close enough to S1 in time to enable the subject to *attend* to both together. In general, the more actively both are apprehended together, the more effective the "conditioning" stimulus will be.

Satisfying and Annoying Effects Differ in Potency.— What situations are by nature and training rather dependable means of producing satisfying and annoying reactions, we attempted to show in Chapter VI. We noted there that some stimuli are more powerful than others. Food to a hungry cat is a more potent stimulus than petting; a bucket of water dashed on a cat is a more intense annoyer than a sprinkling. In general, the greater the intensity of the effect produced, up to a certain limit, the greater the influence upon learning. We also noted in Chapter VI that reactions are satisfying when they relieve some craving and annoying when they fail to relieve a want or when they intensify one. We observed in the same chapter that many cravings are nearly always intense. A craving, moreover, may be severe at one time and less conspicuous or even quite impotent at others. These facts lead to another important principle in education.

THE PRINCIPLE OF READINESS

Human cravings are not equally acute at all times. Hunger is a notable example of a variable craving. A hungry cat displays remarkable energy in trying to learn its way out of a puzzle box when food is placed in sight. The hungrier the cat is, the more satisfying the escape and eating. After having eaten his reward for his first escape, the cat will be less active in his efforts to escape from the box the second time and less satisfied by the food. After a few more repetitions of the performance, the cat may reach a state in which it will do nothing to secure food; indeed, it may actually attempt to escape from the sight and smell of food. Thus a craving may not only dwindle to zero; it may change from a positive to a negative impulse. It is apparent, therefore, that the potency of the general cravings as guides and motives in learning depends upon their intensity or readiness. The facts here indicated may be summarized in a general formula as follows: *The more fully an individual is in readiness to act in a certain way, the more satisfying it will be for him to act in that way and the more annoying it will be not to act in that way. Conversely, the more unready an individual is to act in a certain way the more annoying it will be for him to act in that way.* This statement covers what has frequently been called the "Law of Readiness."

Readiness and the Fundamental Urges.—Readiness refers to the degree of a craving found at a given moment. In the case of any particular kind of craving, it may be said that the greater the readiness the greater the effect upon learning. The fact that most of the organic cravings are so variable in character and acuteness makes them relatively undependable motives for systematic use in education. One of the special reasons why the stimuli such as approving and disparaging remarks were such effective motives, as shown in Chapter VI, was the fact that these stimuli connected with the tasks at hand such tendencies as the desire to overcome opposition and difficulty, the craving to excel other persons, to achieve mastery and social approval—urges which are nearly always "ready to act" and which usually act vigorously.

Readiness and Effect.—The problem of increasing readiness, then, is related to the problem of motivation and both are related to the Law of Effect. It is important to attempt to get learners into a state of readiness for two reasons: (1) Readiness increases the alertness, vigor, and whole-heartedness of the learning activity, and (2) it increases the potency of the factors described under the Law of Effect. The more acute is the readiness to achieve some end, the more satisfying become those reactions which lead toward that end and the more annoying become those which are futile or misleading. Readiness and effect are thus intimately related. One sure means of putting the Law of Effect into operation is to assist the learner to develop ends and purposes which he is zealous to achieve. Such means of increasing readiness and whole-hearted activities we shall consider in later chapters.

SUMMARY OF THE PRINCIPLES OF LEARNING

The various illustrations given in the chapter show that learning is a rather complex process and that in many instances considerable astuteness is required to see just how the general principles function. The first step in developing insight is to get in mind thoroughly the principles themselves. Let us, therefore, state the main principles illustrated in the chapter in brief form so that they may be seen clearly and in relation to each other. The following general statements may be helpful as a means of review.

(1) To exercise a connection means to react to a situation or stimulus. One acquires reactions only by exercising them. This is a general statement of the Law of Exercise.

(2) Other things being equal, when a reaction is made to a stimulus the strength of the connection is increased. The increased strength is due to the modification of the mechanisms, mainly the neurones, involved. As the connection becomes stronger, the response becomes more easy, certain and prompt. This is the Law of Use.

(3) Other things being equal, a period of disuse results in the weakening of the connection between the stimulus and the response. As the connection becomes weaker, the response becomes less easy, certain and prompt. This is the Law of Disuse.

(4) An organism tends to repeat, and therefore to learn, those reactions that are satisfying whereas it tends not to repeat and therefore not to learn those reactions that are annoying. This is a general statement of the Law of Effect.

(5) When a stimulus S1 leading to a Response R1 is presented simultaneously with a stimulus S2 which leads to a response R2 which is *compatible* with R1, connections are gradually strengthened between S1 and R2 and between S2 and R1. Either S1 or S2 will now produce the joint reaction R1R2, each with a degree of certainty, vigor and permanence which depends upon the strength of the newly formed connections. This is an illustration of the Principle of Simultaneous Stimulation.

(6) When a stimulus S1 leading to a response R1 is presented simultaneously with a stimulus S2 which leads to a response R2 that is primarily a satisfying state of affairs, the response S1–R1 is likely to be repeated and rapidly strengthened since the joint response is, on the whole, a satisfying and sought response. This is an illustration of Simultaneous Stimulation operating according to the Law of Effect.

(7) When a stimulus S1 leading to a response R1 is presented simultaneously with a stimulus S2 leading to a

response R2 which is *incompatible* with R1 and incapable of occurring with it, the prepotent response alone will occur and if the simultaneous stimulation is repeated, both S1 and R2 will produce the prepotent response more certainly, vigorously and permanently while the connections of both stimuli with the less potent response are weakened. This is another illustration of the Principle of Simultaneous Stimulation.

(8) When a stimulus S1 leading to a response R1 is presented simultaneously with a stimulus S2 leading to a response R2 which is primarily an annoying state of affairs, the response S1–R1 is likely not to be repeated but on the contrary, the stimulus S1 will tend to lead to a negative or avoiding response of the character of S2. Thus the connection between S1 and R1 is permitted to weaken from disuse. This is again the principle of Simultaneous Stimulation operating according to the Law of Effect.

(9) The most effective way to eliminate an undesirable response UR from a stimulus S1 is to combine the procedure mentioned in (6) and (7) or (6) and (8). First, present simultaneously with S1 a stimulus S2 which leads to a desirable response DR that is incompatible with and prepotent over UR. Thus S1 will become connected with and lead to DR instead of UR. Next, present with S1, leading now to DR, another stimulus S3 which produces the response SR a strongly satisfying state of affairs. S1 now leads to the joint response DR, SR—a response both desirable (from the point of view of others) and satisfying to the child himself. In familiar language this principle may be stated as follows: The most effective way of eliminating an undesirable response is first to set up a desirable substitute and then to present further stimuli which will make the desirable substitute-response more satisfying than the original undesirable reaction.

(10) The effect of a stimulus—that is the kind and degree of satisfying (positive) or annoying (negative) behavior which it produces—depends upon temporary and variable conditions within the organism. A stimulus, for example food, may at one time produce a strongly satisfying or accepting response, at another time an indifferent effect or inconsequential response and at another time an annoying or negative response. These facts are generalized by the statement that the effect of a stimulus depends upon conditions of readiness. The more fully an organism is ready to react in a certain way the more satisfying it will be to react in that way and the more annoying it will be not to react in that way and, conversely, the more unready the organism is to react in a certain way, the more annoying it will be to be forced to act in that way. This is the Principle of Readiness.

(11) Finally, in any concrete case the learning process can be understood and predicted only when the principles of Exercise, Simultaneous Stimulation, Readiness and Effect are *all* taken into account. You cannot explain learning by considering only one of these factors alone.

QUESTIONS AND EXERCISES

1. Using the summary of the chapter as an outline, fill in from memory as much of the concrete evidence as you can.

2. In what respects does the substance of the chapter constitute an enlargement of the statement "We learn by doing"?

3. Compare the activities of a child learning to say "Kitty" with those of a man trying to avoid some painful state of affairs, as described in Chapter VII.

4. Give some illustrations of the attachment of a new stimulus to a response by simultaneous stimulation. Diagram it.

5. Give some examples from everyday life of the detachment of a reaction from its stimulus produced by another stimulus having an annoying effect.

6. Give instances of teaching children in school or at home in which the Law of Effect is ineffectively used or neglected or cases in which bad impulses are actually rewarded.

7. What, primarily, determines what shall satisfy and what shall annoy?

8. Can you give cases where punishment for poor school work has led to a dislike for that school function or for school work in general?

9. What rewards does the school usually give for successfully spelling or reading? What better ones can you suggest?

10. Apply the Law of Effect to the grading, return and display of examination papers. Should papers be returned promptly? Should you emphasize errors only? Should you expect perfection and take it for granted without commenting on it? Should you list the names of the ten best or the ten poorest pupils?

11. How should you proceed to help some one break the habit of smoking? Pitying himself? Getting the "blues"?

12. What might be the effect of punishing a child by making him stay in after school to write all misspelled words twenty times each?

13. Defend or criticize this statement: "The Law of Effect is the most important law of learning."

14. How would you explain learning to disregard the noises in a schoolroom, impulses to play during working hours, or the tendency to feel "hurt" when criticized?

15. If there were no Law of Effect would the learning of a child be more or less at the mercy of his environment? In what ways would we have to change our methods of teaching?

16. If it were not possible to strengthen new connections by simultaneous stimulation, could any learning take place?

17. Suggest the most effective methods of securing the following results: (a) break an adolescent of the habit of "baby-talk"; (b) break a habit of saying "he don't"; (c) teach a dog not to chase cats.

18. Give a plausible account of the development of the following behavior: (a) a child refuses to go to sleep unless the mother sits by the bed; (b) a woman gets a headache when she thinks of doing a batch of sewing; (c) a child refuses to eat unless permitted entirely to choose his own food; (d) a man fumbles a button on his coat whenever embarrassed.

19. Enumerate various factors such as fatigue, etc., which may influence readiness to study arithmetic. What suggestions can you make for securing greater readiness?

20. In what ways does the principle of Readiness suggest that the fundamental nature of the child be taken into account in education?

21. If one child has a greater native aptitude for music than another, which is likely to be more easily interested in music?

22. What dangers are involved in forcing children to learn or perform against their inclinations? Diagram the facts as a case of simultaneous stimulation. Select an illustration from the chapter which involves the same principle.

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CHAPTER IX

CHARACTERISTICS AND CURVES OF LEARNING AND FORGETTING

Learning, as we observed in the preceding chapter, consists in the strengthening and weakening of connections between situations and responses. When two or more stimuli operate at once, new connections may be formed in the sense of being strengthened from subliminal to functioning strength by means of exercise and effect, and old connections may be eliminated in the sense of being supplanted by new connections attached to the same situation. In general, then, all learning may be said to consist in the addition, subtraction and organization of S–R connections. The acquisition of any new complex is the result of a great many additions and subtractions of connections, and each change is brought about in the ways illustrated in the preceding chapter.

Several conditions are needed to provide a typical illustration of complex learning. First, there must be some stimulus to arouse the organism to activity. The stimulus must either produce an annoying situation which the animal attempts to avoid (hunger or confinement would be a sample) or an urge for or impulsion toward some consummatory reaction. Thus hunger, itself a response to a bodily condition, may arouse an urge to secure and eat food. These conditions are necessary, otherwise the animal would settle down comfortably with the result that nothing is learned. Second, the animal must be confronted by a complex situation comprising many features (or stimuli) to which it may react. Third, the successful reactions, in the typical case of complex learning, must be not as yet habituated. With these conditions fulfilled, the operations of the laws of learning may be observed, resulting, as they may, in the weakening or elimination of certain connections, the selection and strengthening of others and the combination of responses into various types of combined reactions.

In this chapter several types of learning will be illustrated with some attention given to their similarities and differences; the learning of animals will be compared with that of man; and the amount, rate, limit and permanence of learning will be treated in a general way.

TRIAL AND ACCIDENTAL SUCCESS IN LEARNING

Learning the Way through a Maze.—If an animal can learn at all, it can learn its "way about." A maze, consequently, is a useful device for studying learning. By using labyrinths of varied difficulty it is possible to get a rough measure of the learning capacity of different species.

Usually, mere confinement in a maze is sufficient to arouse the animal to activity, but often food is added as an incentive; the animal is rewarded by finding food at the end of the correct course.

A worm, a small chick, or a turtle can master a simple maze; but a rat, which is able to learn fairly complex pathways, is more frequently used in experimental work. Placed in a maze, as shown in Figure 23, the rat begins to nose about cautiously. He explores here and there, sniffing at everything as he goes. A human subject would study the features encountered, with his eyes rather than his nose. After going into a blind alley, the rat explores it thoroughly before coming out. If it receives a slight electric shock on reaching the terminus of certain blind alleys, it scampers out and very likely moves on or possibly retraces its steps to the more familiar territory already covered. After a time, it will venture again, and perhaps after many errors eventually finds its way through the maze to the food box. During a second trial, the rat works its way through the maze cautiously as before, but with fewer entrances into blind alleys, especially those wherein the shocks were experienced. It takes many trials, the number depending in part on the complexity of the maze, before the rat, by a gradual process of elimination of annoying errors and acquisition of satisfying correct reactions, is able to follow the proper course unerringly. The rat has now acquired a series of reactions which with reference to the features of the maze situation are new. So far as one can observe, the learning process consists of:

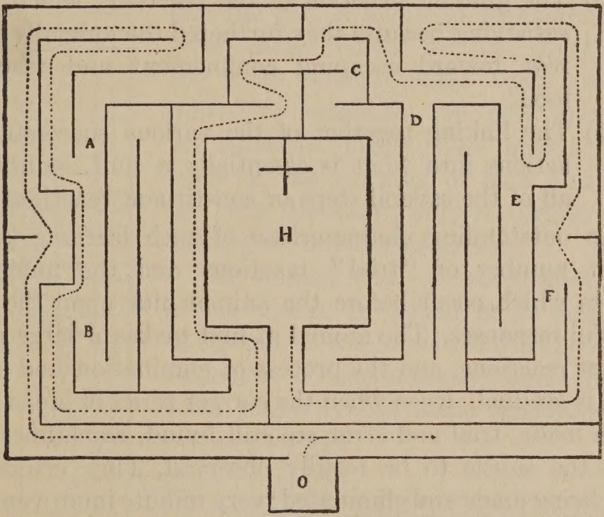

Fig. 23.—The Hampton Court Maze, Frequently Used in Studying the Learning of Rats and Other Animals. The animal is admitted at O. Food is placed at H. The dotted line indicates the direct pathway; A, B, C, D, E, F indicate blind alleys. (From Watson's *Behavior*.)

(1) The making of reactions, native or previously acquired, to the features of the situation, *i.e.*, old reactions which constitute the "trials";
(2) The gradual elimination of the annoying errors, *i.e.*, the old or trial reactions which bring painful shocks or which end in failure to relieve the confinement;
(3) The gradual selection of the reactions which were satisfying because they furthered the animal's progress toward escaping confinement and reaching food;
(4) The linking together of the various successful reactions into what is essentially a unit, embracing all of the several steps or constituent reactions.

An outstanding characteristic of such learning is the great number of "trial" reactions and the numerous errors which occur before the animal hits upon the successful responses. The animal at first makes a large number of reactions, and the process of elimination and selection is gradual. Even when the correct series of steps have been made, trial and error are still found, sometimes of a sort too subtle to be readily observed. Tiny errors are still being made and eliminated; very minute improvements are constantly being achieved. The progress of learning is not steady; the number of errors made or the amount of time taken gives a zigzag *curve of learning* as illustrated in Figure 24. This type of learning is described most frequently as "*trial and error*" learning, but perhaps more adequately as learning by *trial and accidental success*.

How Human Subjects Learn a Maze.—If a college student is given a maze to solve which is as difficult for his species as the one described is for rats, the general process of learning will be the same. Hunger or annoyance at confinement may not be required to arouse his activity and thus make learning possible, but some motive—the desire to accomplish something, to learn something, to display ability, to get through with a prescribed experiment—must be invoked. Once under way, the student proceeds until an error is made, whereupon he retraces his steps and goes ahead again. If he receives an electric shock in some blind alley, he, like the rat, is likely to eliminate that error early. When he has completed the maze, several more trials are required to establish the new, successful reactions firmly. The general features of the learning of men and rats are thus the same; only in certain particulars do differences appear.

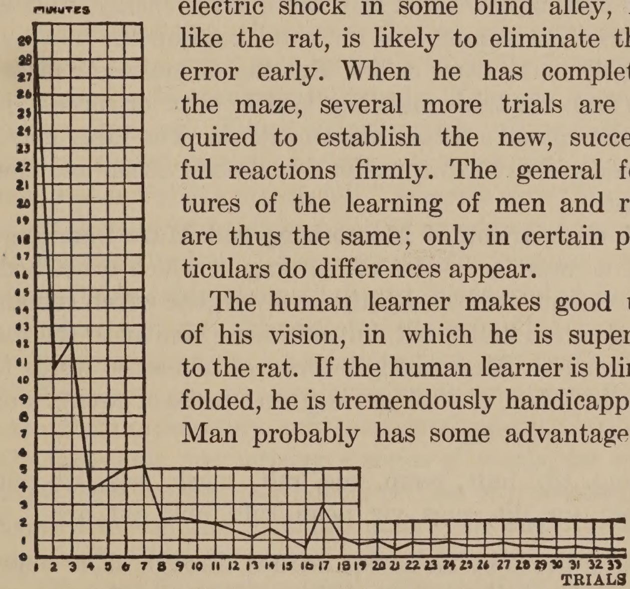

Fig. 24.—A Curve of Learning the Hampton Court Maze (Shown in Fig. 23) Based on Records of Four Rats. The vertical column of figures at the left indicates the time required for the trials, which are numbered along the base of the figure. (From Watson's *Behavior*.)

The human learner makes good use of his vision, in which he is superior to the rat. If the human learner is blindfolded, he is tremendously handicapped. Man probably has some advantage in the modifiability and retentiveness of his nervous system, that is, any reaction made has a greater effect; it is "stamped in" or "stamped out" more readily. If he notices a sign on the right way or gets a shock in the blind alley, these experiences are retained better. The human learner also indulges to a greater extent in mental activity. By means of memory, he can represent or recall some of the situations and the responses which he made to them. Arriving at an intersection of paths, some sign—the look of the place—may enable him to recall the alley and what he did in it at the last trial. Man, more than the animal or even the child, stands at the crossway and contemplates, and thus often saves energy, time and errors. The animal and the child keep on the move and usually make more errors. But the memories or ideas of the man are trials and may lead to error or success, just as the animal's actual movements do. The ideas may be considered as substitutes for actual observation and movement.

A Comparison of Memorizing and Maze Learning.—Let us examine a case of learning in which overt bodily movements are but slightly involved; one which is mainly observation and recall, but otherwise similar to the maze experiment. Memorizing a series of non-sense words is a case in point. The subject is given a series of twenty words like the following:

> nup, tib, nult, remp, zuc, ralt, marb, selz, kib, curg, toq, sor, dit, quos, viz, pelm, rulb, onk, qat, arz.

Such a list is by no means learned through sheer impression, absorption or repetition. While the learner may not always realize it, the process comprises false starts and stops, errors, confusions, the addition of connections, elimination of connections—all of the features of learning a maze.

A typical attack by an efficient learner would be somewhat like this: First, a reading of the series for purposes of general orientation; next, perhaps careful observation of the first and second syllables and possibly the last two —nearly always these are learned first. Then the whole series may be broken up into units or "feet." The first foot may contain *nup*, *tib*, *nult* and be read with a rhythm such as –′ co followed by similar feet. The first syllable in each of these groups may be observed with special care. The learner may note and try to remember that the last word of the first group, *nult*, has four letters, and that it is followed by another, *remp*, with four letters. However, he may discard this when he finds that *tib-nult* may be combined into a word that sounds a little like a town he once visited, and this in turn may be discarded when he observes that *nult* almost rhymes with *ralt*, which occupies a similar metric position. A word like *quos* is thought of as "such a mouth full"; whereas *viz* is "buzzy" and *dit* is short and snappy. *Selz* is remembered because it is short for "seltzer." Learners usually keep an active lookout for meaningful reactions and this is trial and error in its clearest form. Suppose, for example, that you see how many meaningful associations you can make with *gip?* Note how you try, one after another, a great many ideas—some satisfactory, others unsatisfactory.

On the whole, memorizing a series of words, far from being a mere passive, mechanical process of repeating one syllable after another, is highly active—or reactive—and presents all of the features of other trial-and-error learning. The good learner is actively observing and searching for clues. He tries reacting by possible meanings, possible sounds, possible combinations with other words, possible similarities or contrasts. Many of these are tried out only to be discarded; others are selected; and before the list is learned the path is strewn with discarded trials. What is finally learned is an integrated series of reactions, just as the trip through the maze was a coördinated series of reactions.

In memorizing, just as in learning a maze, one attains the first successful trip through the series after many trials, and even with that achievement much remains to be learned by further practice. There are recurrences of difficulties and errors—the curve of learning is zigzag, like that of the rat's in the maze.

Trial and Error in Complex Learning, Typewriting.—Learning the way through a maze and memorizing a series of non-sense syllables are relatively short tasks, at least for human subjects, although it would be possible to make them so long and difficult as to require weeks of effort. Many of the more familiar functions such as reading, writing, drawing, singing, playing the violin, running the typewriter, diagnosing disease, writing poetry, etc., etc., require years of practice to achieve a high degree of proficiency. One of the best illustrations of the character of learning in such complex functions is afforded by studies of typewriting (as made by Book and others).

Following one method of learning, the subject starts to work as follows: Looking at his copy, he finds the first word "what" and thinks of "w." He now looks at a picture of the keyboard, locates "w," and then, finding a corresponding position on the actual keyboard (the letters of which are covered), he makes a stroke. The same procedure is followed for "h" and "a" and "t." After a time, the task of looking at the picture of the keyboard is eliminated, first for a few and gradually for more letters. The process then is: see the word, think of the first letter, "w," think of its position on the mental picture or representation of the keyboard, locate its position among the keys and strike. The keyboard has been reacted to consciously (by observation) until it may be represented mentally, *i.e.*, it has been memorized. Of course this is a gradual process so that prior to complete mastery there is an overlapping; some letters may be recalled, while others must be looked up. Needless to say, writing at this stage is very slow and errors are frequent. Shortly the learner finds that the mental image of the position of the keys is unnecessary for certain letters; they may be thought of as on the board. Later, it becomes unnecessary to *think* of the position of certain letters at all. Merely seeing the letter to be written acts as a stimulus to carry the hand and finger to the right spot. The elimination of the several mental steps results in a great saving of time, energy and usually, of errors. While there has been great progress, however, in respect to the elimination of many useless acts and the perfecting of the finger work in striking the keys, the learner is still in the "letter stage," making a particular complex reaction to each letter.

Further eliminations and selections, almost too subtle to be observed by the experimenter or to be appreciated by the learner, result in a combined reaction to two letters. For example, when "what" is observed, the thought of the "wh" sets off two strokes as if they were a unit; the same for "at" and for other similar units that are frequently encountered. While this unification is spreading to less familiar combinations, longer units such as "are," "The," "ter"; and soon "they," "ough," and later whole words or even phrases are written as integrated or unified acts. The transitions to broader units are made at different stages for different words; the easier or more frequently used first, the more difficult or infrequent later.

Meanwhile speed and accuracy have been steadily but irregularly increasing. Numberless futile reactions have been discarded. At first the learner may grit his teeth, press the table with his knees—literally write all over. These reactions are gradually eliminated as are more subtle irrelevant errors which result in hitting too hard or too easy, in missing the keys, or timing badly so that the keys clutter frequently. Periods of emotional upset, anger, chagrin, despair, disgust, great elation, and the like are very common at first, but are brought under control. In learning to typewrite, one must learn to adjust his emotional as well as his motor mechanisms to the situation. The elimination of conscious reactions, actual thoughts or images of positions, particular letters or particular movements goes on similarly. In the expert stage there are, then, relatively few irrelevant reactions. All of the movements become integrated; that is, they become combined into what is essentially one complex action. Attention need be given only to one phase of the process and with increased mastery less and less attention or only occasional attention is required.

THE RÔLE OF IDEAS AND OBSERVATION IN LEARNING

Learning by Purely Mental Trial and Accidental Success.—In the illustrations given, the learning of animals and man is about the same except that the human subject learns more rapidly, retains better, masters more complex functions and utilizes to a much greater extent ideas as a substitute for actual manipulation, walking or other motor responses. While not changing the fundamental *trial and error* character of the learning process, the use of ideas, making "trial" reactions mentally instead of overtly, is usually of great value. It is of value not merely because it saves time and energy, but for other reasons, some of which may be explained more intelligibly when we take up forms of learning in which "insight" into, or perceiving a general principle in a complex problem assists in mastering the mechanical solution. At this point, a few other important advantages may be described. The first is the possibility of practicing in the entire absence of the situation.

It is characteristic of a man learning to drive an automobile, play cards or build a house to keep on working at it in "off hours" during the process. He recalls to mind the position of the gears, brake and throttle; mentally he turns on the ignition, adjusts the levers, shifts gears, turns corners, stops, backs and so on. He may picture his "hand" in cards, make plays, visualize the results; in building the house he mentally places the staircase here, the fireplace there and then contemplates the results from various angles. In these operations, he makes trials, detects errors and observes successes. It is an interesting armchair type of learning, tremendously labor-saving and by no means futile. One of the notable features is the possibility of getting down to essentials, of avoiding disturbing or irrelevant details. When actually driving the car, for example, obstructions in the road, the need of steering, disturbing bumps and fears interfere with concentration on shifting gears. Lying abed in the morning, one may get right down exclusively to the matter of shifting the gears, repeating the operation time after time. Such practice really carries over to some extent but rarely fully. Mentally shifting gears clarifies the mode of procedure but does not increase specifically skill in the muscular operations. A fine move in cards, or "idea" about the position of the staircase in the house may be put into effect easily, but often we find that some essential has been overlooked, we forget the possibility of some one's being out of suit and "trumping" or the fact that the staircase position interferes with the light inlet. Even so, mental trial-and-error learning is of tremendous value in point of economy and efficiency, much more in some functions than in others. By virtue of these capacities, man has a great advantage over the animals that do not utilize ideas much if any.

Learning by Observing Others Perform.—The human learner is often able to acquire methods of procedure and detect erroneous and successful moves by observing others perform. Take a knife, cut a piece of elm, strip the bark, make a few notches in the wood, replace the bark with a slit in it and a gust of air properly applied produces a whistle. A group of small boys having observed these operations could go and do likewise, although they often observe incompletely and wrongly or forget what they perceived.

Animals seem rarely to be able to learn by observation the tricks they can readily learn by trial and error. In performing experiments on animals, one must be sure that the animal observes another's performances, that it then attempts to learn, that it has not already learned and that it does not learn by pure trial and accidental success, without profiting by what is observed. Sometimes in these experiments the performance of the act is done by the experimenter, sometimes by another animal that has mastered the act. The acts utilized are such as jumping up or down a series of steps, standing upright, clawing, pushing, pulling or pecking at a certain latch or button, using a T-shaped stick to rake in a piece of food, climbing to a perch from which food may be reached, using a stick to push food out of a glass tube, reaching into a bottle to pull food out, etc. Nearly all animals show what, compared to the behavior of a bright child, appears to be astounding stupidity under such conditions. While there are a very few cases of learning, mainly among monkeys, chimpanzees and other primates, which may have been due to observation, usually the animal profits nothing by observing a performance even ten or fifty times. Learning a performance by observing is rare even among the most intelligent beasts. They must learn through the try-and-try-again process with little abridgment. While they may appear to be as observant as human beings, we may be certain that their observations are markedly less effective. At the most they seem to learn merely that such and such is the *place to work*, without learning perceptibly *how* to work. In the anecdotes of animal learning that most of us hear from time to time, what is alleged to be the learning of an act by observation is really learning merely a place to work.

Children and adults learn much by observing performances by others and thus abridge the trial-and-error process considerably but rarely fully. If the act observed is very simple and within our motor, emotional or mental equipment at the time, we may be able to do it. If I clap my hands 1, 2, 3, stop, 1, 2, 3, stop, etc., you may be able to observe and immediately to repeat these acts which you are already able to perform. But if I pat the top of my head rapidly with my left hand while rubbing my abdomen slowly with a circular motion with the right, you may observe the act and yet be unable to do it. Now, reverse the hands. Patting the head with the right hand, while rubbing the abdomen with the left, while no harder to observe, is much harder to do. Observing the skilled pianists is of some value to the novice but by no means a substitute for trial-and-error learning. Furthermore, a person may observe how well another controls his anger at interference, his fear of thunder, his grief at misfortune and while often helpful in some measure, such observations are not enough to enable one to do the same. Similarly, observing skilled acts in tennis, boxing or drawing hundreds of times, while often helpful, is not alone sufficient. Learning by observation of a performance is rather exclusively human. It is a valuable supplementation of, but by no means a complete substitute for, the trial-and-error procedure.

Summary and Conclusions.—In sum, however more complex human learning may be than that of animals, the fundamental features are addition, elimination and recombination of neural connections during the process of trial, error and success. In addition to native advantages in rate of neural modification and retention, the human learner is more proficient because he can and does observe more and better the results of his trials and errors; because he can and does utilize more and in better ways, ideas developed during observation; because he can and does recall these ideas in the absence of the things observed; because he can and does observe and profit by the performance of others. It should be understood, however, that the learning of animals differs from that of men only in degree. Some animals learn more readily than some human beings.

THE COURSE OF IMPROVEMENT IN LEARNING COMPLEX FUNCTIONS

Before undertaking a discussion of the means of learning most rapidly and economically, it will be advisable to observe typical human progress in several complex functions which have been learned with little guidance or tuition. Such investigations yield a picture of many characteristics of representative human learning rather than of the progress of learning as it might appear under ideal management and tuition. We shall take up first various features of the *curve of learning*, which gives a graphic picture of the amount, rate and limit of improvement brought about by practice.

Most of the functions learned in school or everyday life are very complex, including many particular S–R connections. During the progress of learning, changes in the combination of connections are constantly going on. *The final proficiency is not merely the performance at the beginning done more rapidly; it is a different performance.* Curves of learning, consequently, portray the progress of improvement in a changing complex of connections. They do not picture the influence of exercise and effect upon a single neuron or even upon a constant group of S–R connections.

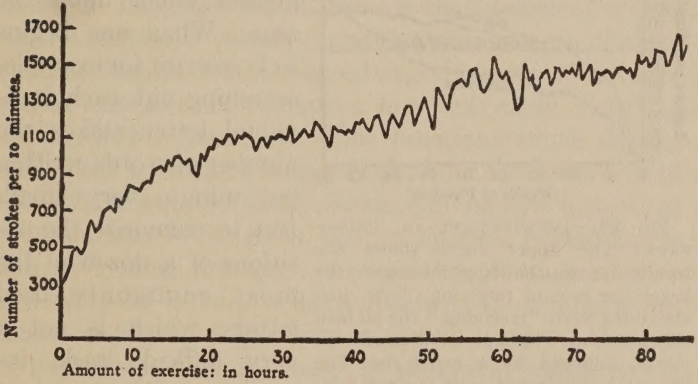

FIG. 25.—CURVE OF IMPROVEMENT IN TYPEWRITING. Between hours 25 and 45 little improvement is made. This period might be called a plateau. (From Thorndike, *Educational Psychology*, Vol. II, after Book.)

Shape of Learning Curves.—The actual curves of learning, which are available in large numbers, are of various shapes. The forms are determined in part by the nature of the function itself and in part by the ability, methods of work and previous training of the individual learner and the circumstances under which he works. There is no single or typical curve of improvement, but many different varieties of which a few representative samples are given in Figures 25 to 28, inclusive.

Study of the various curves will show that a rapid initial rise is a frequent but by no means universal characteristic. The actual increase in the output often rises rapidly in the earlier stages and usually more slowly at the final stages of an extended experiment on the acquisition of skill. This is not necessarily an indication that one is learning better in the early stages; usually it means only that what is learned has greater effect upon the score. When one begins to typewrite, for example, searching out each individual letter makes the number of words written per minute very small. But to memorize the positions of a dozen of the most commonly used letters, which is not a very difficult task, increases the output greatly. When one has reached a speed of thirty words per minute most of the easy tricks have been mastered, and to secure an equal increase in the score demands the learning of a great many more difficult acts. If, on the other hand, we consider the number of new Latin words one can learn in a given unit of time, we shall probably find that it increases as practice goes on. This is due, mainly, to the fact that after one has mastered a number of roots, prefixes, rules, etc., it is an easy matter to pick up a dozen new words; the "new" words being, as a matter of fact, not wholly new but composed of one or more parts already more or

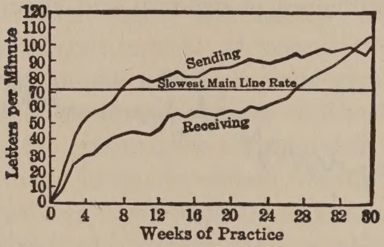

FIG. 26.—IMPROVEMENT IN TELEGRAPHY. The upper curve shows the results for transmitting messages; the lower the rate of receiving. Note, just above the word "receiving," the plateau which extends over a period of nearly ten weeks, followed by a rapid rise. The line marked "slowest main line rate" indicates the slowest rate at which commercial messages are sent. (From Starch, *Educational Psychology*, after Bryan and Harter.)

less familiar. This is usually the case in acquiring information; the more history, psychology or mathematics one already knows, the easier it is to learn a new lesson. Such differences in functions result in different kinds of learning curves.

The Physiological Limit.—In the case of such skills as typing, writing, etc., an absolute limit of improvement is theoretically possible but practically almost never achieved. The *physiological limit* is that degree of ability which a particular person cannot surpass because of absolute inherited limits in the speed or complexity of motor or mental response. In running a hundred yards, jumping, tapping with a pencil or other functions which depend upon sheer speed and force of muscular contraction with relatively little opportunity for developing new technique, the limit may be reached. But in complex performances such as typing, drawing, playing the piano, carpentry or surgery it is very seldom reached. In acquiring information in any field—law, medicine, history—there is no physiological limit; there is always a possibility of learning more, although there is a limit to the speed with which the items may be acquired. But in most functions which have been steadily practiced for years, such as writing, reading, shaving, opening envelopes, tying neckties, sorting cards, memorizing or studying, we are performing with a speed and efficiency far below our maximum possibilities. Under special incentives such as keen competition, typesetters, telegraph operators and typists in industry, as well as readers, writers or spellers in school, frequently rise abruptly from a dead level which had held them for years.

When any habit becomes fixed, it is invariably annoying to disturb it. The prime condition of improvement is that the performance at the time be broken up and reorganized in better form, *i.e.*, on a higher level. Most of us eased off in our learning of reading, writing and many other school functions as soon as we safely could—perhaps in the fifth or sixth grade—and entrenched ourselves in a low-level performance, from which we have never emerged. Few people know how rapidly they read or write, how efficiently they memorize or solve arithmetic problems; few know when their improvement came to an end, or whether they have made any improvement in the last year or ten years. If you should now suddenly undertake to increase your speed of reading it would be found disturbing and perhaps unpleasant for a time, the inevitable result of breaking up an old organization of habits to supplant them by new. But this is the only way

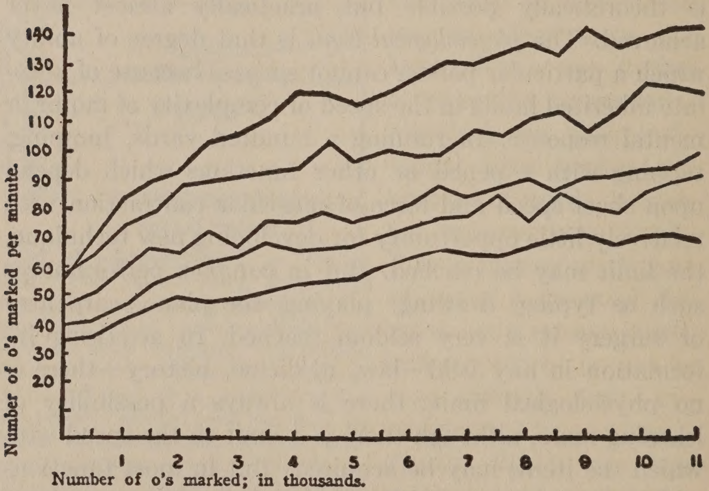

Fig. 27.—Improvement in Cancelling O's from Rows of Digits by Five Subjects.—Note that the shapes of the curves differ among individuals and that the largest improvements are made by those who show the greatest ability at the beginning. (From Thorndike, *Educational Psychology*, Vol. II, after Wells.)

in which more effective habits—perfectly comfortable once habituated—are attained.

Even in learning under experimental conditions, in which the incentives to improve are great, especially when each day's work is recorded, the progress measured, rewards offered and competition provided as incentives, the tendency to ease up is quite usual. Sometimes this shows itself in a level or "plateau" in the curve, although some levels, even declines, are otherwise occasioned. Figure 26 illustrates a plateau out of which the curve of learning emerges to reach higher levels. Often under ordinary conditions of life, where actual improvement is not insisted upon, cherished and rewarded, the plateau becomes a permanent level.

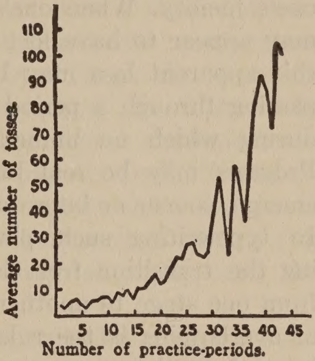

FIG. 28.—IMPROVEMENT IN TOSSING AND CATCHING BALLS. The improvement is slow at the start but becomes more rapid as the subject becomes more proficient. Compare with Figures 25 to 27. (From Thorndike, *Educational Psychology*, Vol. II, after Swift.)

Plateaus in the Learning Curve.—Plateaus may, however, occur despite an interest in improvement and an effort to secure it. Sometimes they are due to unintentionally but unhappily hitting upon a bad habit or method which interferes with further progress until it is eliminated. In writing, a pupil may develop an unfavorable sitting position or too firm a grip of the pencil; in reading, a habit of pausing too frequently in a line, or of giving too much attention to the minute details of words; habits which may inhibit progress until they are accidentally or by means of the teacher's instructions corrected. Plateaus may be caused by eye trouble, fatigue and other physiological conditions, despite intentions to improve. Sometimes levels in the curve, persisting for days or even months and often discouraging to the learner, are encountered when actual progress is being made. In golf, tennis or other forms of skill, the introduction of an improved grip, position or stroke may temporarily disturb one's facility. When one's performance is measured one may appear to have lost some ability; but the cause of this apparent loss may be the fact that the learner is passing through a period of transition to a higher level during which no immediate improvement is secured. Progress may be real but concealed; the learner may emerge, sooner or later, with greater ability than before. In typewriting such plateaus sometimes appear during the transition from letter to word units. The shift from one stage to another is seldom abrupt; a good deal of overlapping is the rule, and while the one is shading into the other, errors and periods of confusion are frequent. The danger is that these will so annoy the learner that he will drop back to the lower but more familiar level instead of persisting until the new habits are mastered.

Short Time Fluctuations in the Curve of Learning.—The plateau, which is a long time level or depression in the curve of learning, lasting for weeks or months, is not a universal characteristic of any function or any person; but short time, day-to-day ups and downs are practically universal. (See Figures 25–28.) These fluctuations are due to temporary habits, good or bad, differing bodily conditions, interests, distractions, incentives, varied states of readiness or other temporary influences. Individuals will have not only good and bad days, but good and bad hours, or minutes, during the same day, often for reasons that are difficult to discover.

THE INFLUENCE OF DISUSE

Disuse is, of course, a passive state in which the mechanisms, trained during practice, are left inactive. The effects of practice gradually die out at a rate which depends upon the native retentiveness of the particular neurones for the particular individual concerned. No satisfactory information has as yet been secured concerning the precise rate at which particular connections strengthened by exercise weaken through disuse, or to what limits the effects of disuse may go. The whole matter of the change in particular neural elements occasioned by disuse must be treated hypothetically by deduction from the rather crude experiments upon complexes of connections, constituting functions such as memorizing words, or historical data, learning telegraphy and the like.

In the previous chapter, we described a case of a child who learned to react to the spoken word "leaf" by thinking of the object when the word and object were presented together repeatedly. To begin with, the connection between the word "leaf" and the idea of leaf was very weak. In Figure 29 this is represented as above zero but below the "limen" of recall; that is, the connection is not strong enough actually to produce the response. One simultaneous reaction to the word and the object strengthens the connections somewhat, but not sufficiently to provide the response. Further repetitions gradually increase the strength of the connections until, perhaps, after thousands of repetitions, it reaches a limit—the physiological limit—which represents the strongest and most permanent connection possible. There are, then, various degrees of strength in a connection, from zero up to the threshold (or limen) of reaction and from that point on to a theoretical limit. One may study an item to a point where he can barely recall it, or overlearn it to various degrees. The more thoroughly it is overlearned, the more promptly, surely and easily it can be recalled. If the reactions are now given no exercise, disuse gradually results in a weakening of the strength of the connections, which would result in a lessening of the promptness, certainty and ease of recall and, finally, in inability to recall. But even when the connection becomes so weak as to lie below the limen, there are still differences in degrees of strength, or in other words, differences in degrees of weakness between the limen and the zero point.

Overlearning and Disuse.—From the experimental studies, which are unfortunately very few, it appears that the rate at which connections lose strength through disuse depends mainly on how strong they were at the beginning of the period—that is, on how much they were overlearned. Reactions greatly overlearned, such as our names, the A B C's, and many familiar words, or motor acts as holding a pencil, or humming "Home, Sweet Home," will probably function after thirty, forty or more years of disuse, although they will have lost more or less of the original promptness and ease of action. Names of old friends, the appearance of the scene of a summer's vacation, a poem or song greatly overlearned, the act of catching a baseball and other acts representing connections less thoroughly established, will remain above the threshold of reaction for many years, and thus, by various degrees, we may come down to responses that were originally exercised sufficiently to place them barely above the threshold of reaction.

Curves of Forgetting.—It is upon functions barely learned that most of the experimental studies of the effects of disuse are based. A pioneer investigator in the field (Ebbinghaus) examined the permanence of his own learning of non-sense syllables after they had been barely learned—that is, learned until he had made just one correct recitation. Practice was given up, and after a period of disuse he relearned the same series. The loss in the strength of connections—or, as it is more accurately expressed in this case, "the amount of forgetting"—is measured by the relative amount or percentage of time taken to relearn the material to the point of one recall.

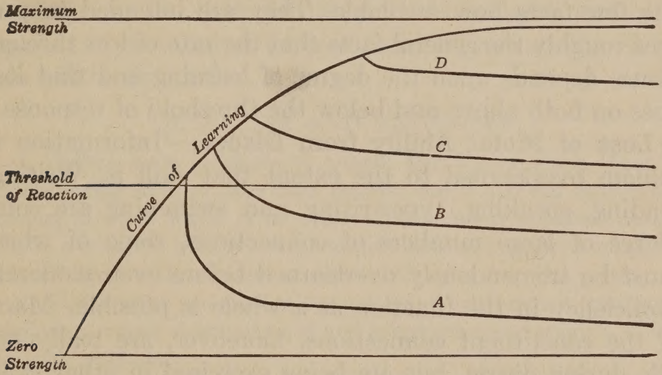

FIG. 29.—PROBABLE INFLUENCE OF DISUSE IN THE CASE OF FUNCTIONS OVERLEARNED IN VARIOUS DEGREES. Curve A shows the loss or forgetting which occurs when the function is barely learned. The initial loss is rapid and great, followed by a much slower rate of deterioration. B, C and D show probable losses in functions which are overlearned slightly, considerably and greatly, respectively. In all cases, after the rapid initial loss, the strength of the connections steadily but slowly decreases.

The loss of ability, as thus measured, is very rapid at first and then tapers off gradually. In another study (by Strong) were obtained about the same results when different materials and a different method of measuring forgetting was used. Another investigator (Radosavljevich) found that when non-sense syllables were learned more thoroughly, namely, until they could be recalled twice in succession, the effects of disuse were not so great. The first investigator found that after twenty-four hours of disuse, two-thirds of the original time was required to relearn, whereas the last investigator found that when material was overlearned slightly (two correct recitations instead of one) only one-third of the original learning time was required to relearn after twenty-four hours.

Figure 29 illustrates roughly the probable curves of disuse which may follow various stages of overlearning. These relations, however, are merely estimates based upon the few facts now available. They are intended to present roughly the general facts that the rate of loss through disuse depends upon the degree of learning and that loss goes on both above and below the threshold of response.

Loss of Motor Ability from Disuse.—Information is seldom overlearned to the extent that skill is. Writing, reading, speaking, typewriting and swimming are complexes of large numbers of connections, some of which must be tremendously overlearned before even moderate proficiency in the function as a whole is possible. Many of the constituent connections, moreover, are really not idle during disuse, but are being exercised in other skills and thus kept strong. With complete disuse, the connections involved in motor functions do die out and, when originally overlearned to the same degree as the bonds involved in acquiring information, the rate of deterioration is probably about the same.

Degree of Retention Conditioned by Methods of Learning.—The effects of practice, then, die out gradually at a rate which depends on the amount of overlearning, and on the native retentiveness of the particular neurones in the particular person concerned. There is no way in which one's native retentiveness may be increased so far as is now known. Whatever the degree of native retentiveness anyone may possess, the permanence of his retention is influenced by the way in which he learns, by the time he spends in practice and by the way in which the time is spent. Learning, as was illustrated earlier in this chapter, is more than mere repetition. Economical learning and as a consequence optimum retention—since retention is a passive matter depending partly on the process of learning—depends on utilizing effective incentives, on eliminating the wrong and selecting the right reactions with dispatch, on overlearning to the right degree, neither too much or too little for the purpose in hand, and on a number of economical devices to which succeeding chapters will be devoted.

QUESTIONS AND EXERCISES

1. Collect some instances of animal learning in which ideas or understanding seem to have been present. See if you can explain the learning in other ways. If no other explanation is apparent should you, as a scientific thinker, conclude that ideas and understanding are present? Review the relevant sections of Chapter I on this point.

2. Thirty years ago most of our notions of how animals learn were based upon casual observations of and anecdotes about animals. Criticize such methods.

3. In what respects is the learning of animals like that of man? In what respects is it different?

4. An experiment upon improvement in reading. For practice, attempt to speed up in all of your daily reading for thirty days. Try to bring about an increase in speed by pushing yourself beyond your ordinary rate. Give yourself a test, at about the same time each day, by getting some one to time you while you read for ten minutes as rapidly as you can comprehend. For test material use a book of moderate and uniform difficulty. Record the number of lines read on each ten-minute test. Plot a "curve of learning."

5. Compare your progress with that of others. At the end of thirty days, see if you think you have reached your limit. How can you be sure whether you are on a plateau or at your physiological limit? Test your judgment by continuing the experiment. Was the general curve uniform or irregular? Can you account for the small variations from day to day?

6. Just what is meant by the physiological limit? In what func-

tions have you reached your physiological limit? See if you can increase your speed of tapping or of saying the ABC's.

7. Name functions in which a slight improvement can be attained only at a great cost of time and effort. Name some where the experiment is worth the cost; some in which it is not.

8. Give samples of functions in which a little improvement may be of enormous practical importance.

9. How may we determine the optimum development of school functions—reading, spelling, writing, typewriting, speed and accuracy of multiplication? Cite opinions or experimental evidence concerning the degree of efficiency demanded by various vocations.

10. Can you give any illustrations from your own experience in which improvement has been blocked by the formation of inappropriate habits, loss of interest, staleness, or fatigue?

11. What is meant by "overlearning"? What is overlearned when one can typewrite sixty words a minute?

12. Cite a dozen functions which the high school graduate has overlearned. In what cases has there been too much, in what too little overlearning?

13. Suggest an effective way of relearning poetry or names in order to give special practice to those bonds which generally need relearning?

14. What does a pupil in school know about his curve of learning in various functions? What should he know? How might such curves be secured?

15. Criticize this statement: "We learn to swim in winter, and learn to skate in summer." Account for any appearance of improvement as a result of a period of no exercise.

16. Why is it that certain experiences of childhood are apparently very well remembered?

17. In what functions does it appear that loss is very great from disuse? In what ones does it appear to be less great?

18. James states that "Nothing we ever do is in strict scientific literalness wiped out." Just what is meant by this? Certainly, experiences are "forgotten," that is, cannot be recalled consciously. What has become of them and how may they function? What evidence can you cite to show that some trace of past experience may function years after it is forgotten in the sense that it cannot be consciously recalled?

19. Is there a single typical curve of forgetting for all functions?

20. If one plays tennis only two months per year, but plays baseball

three months and handball seven months, would you expect the skill in tennis to deteriorate during the ten months as much as if baseball and handball were not played at all? Explain.

21. List and define all the new terms found in this chapter.

REFERENCES

Comprehensive brief accounts of the characteristics of improvement from practice will be found in the following:

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CHAPTER X

PRINCIPLES OF GUIDANCE IN LEARNING

Animals are unable to profit materially by the observation of the performance which they are striving to learn, by the use of models or by guidance mediated through ideas otherwise expressed. The human learner, on the other hand, may profit considerably by insight achieved by observation and by instruction concerning methods of procedure. Both human and animal learners may be helped, moreover, by means of properly managed motivation, rewards and punishment, by the optimum arrangement of practice periods, their length and distribution. and by other types of mechanical supervision. To these methods of abridging the process of learning, which is laborious enough at best, the present chapter will be devoted.

The principles of economy will be grouped with reference to two types, or really two phases of learning:

(1) The acquisition of motor reactions or skills.
(2) The acquisition of facts and information.

This division is made not because the principles differ in the two instances—they are essentially the same—but merely for convenience in discussion. Were the principles of economy fundamentally different for the several phases of learning, practice in most functions would afford most puzzling problems. For example, in learning to read one must take care of the formation of proper motor reactions, the highly complex habits of eye control and the management of articulation, audible or silent, and of the acquisition of ideas, that is, of comprehension or thought getting.

If the rules for guidance were essentially different for these phases—and in almost every instance of human learning both are present—marked economy could scarcely be achieved. Fortunately, the main principles are everywhere the same; although, unfortunately, in many instances they are not altogether clear.

PRINCIPLES OF GUIDANCE IN THE ACQUISITION OF MOTOR SKILLS

Evidence That Guidance Is Desirable.—We need only to point to the "hunt-and-hit" methods of typewriting, the pointing-with-the-finger procedure in reading, the cramped grips in writing, the "dog-fashion" strokes in swimming, to convince most people of the inadequacies of unguided learning. By teaching and guiding the learner to acquire the "touch method" of typing, the proper eye movements in reading, the positions and functions of the fingers in writing, or the "crawl" stroke in swimming, much higher proficiency is achieved. The learner left to himself usually adopts the first method he stumbles upon, a method that is rarely good. The effective methods often are more difficult in the early stages. Immediate returns are often meager, and, in general, the unguided learner seeks immediate progress; he follows the line of least resistance. Not only, then, is it the business of the instructor to know *what* the child should learn but also *how* he should learn.

Know the Character of Effective Performance.—The first requirement of an instructor, or of a person managing his own learning, is knowledge of the character of the good performance. To determine this is often difficult and may be done only by extensive research.

The way in which modern methods of teaching reading grew out of experimental investigations is a good illustration. Four discoveries made at different times between 1879 and 1910 are the fundamental, but not the only ones upon which modern methods are based. One was the discovery that the eye, in reading, moves along the line by a series of starts and stops; the second, that the eye while at rest can take in briefly about an inch and a half of a line of print held the ordinary reading distance; the third, that one need not see distinctly all of the letters, or even all of the words, in an "eyeful" to recognize the group of words and the fourth, that a child, having first learned to speak words, tends to speak, silently, if not audibly, the words he reads. These discoveries led to new methods in which were emphasized learning to recognize words as total configurations instead of letter by letter, learning to read by mere visual perception instead of by complete articulation of words, and learning to utilize rapid and rhythmic eye-movement progressions along the line. Shifting from the old to the newer procedures has enabled young and mature readers to increase the thoroughness of comprehension and to increase greatly, sometimes to double, the rate of reading.

The combined arm-and-hand movement method in handwriting, the "touch" method in typewriting, the "crawl" stroke in swimming, have been the results of investigations, either crude or refined, of the relative merit of different types of performances. While much remains to be learned concerning different methods even in the simpler school skills, such as writing and drawing, a teacher of these subjects should at least know the available information about the relative merits of different types of performance.

The Observation of Performances and Models.—Having ascertained the detailed operations that will yield the best results, how are they to be taught? The first problem is that of taking advantage of human capacity to profit by observation of a performance or a model. Choice here is determined entirely by the clearness with which the performance or the model illustrates what is to be done. Despite the large number of functions in which learning is more or less guided by our observations of others in action, most of the motor activities in common skills are exceedingly difficult to perceive. Inasmuch as he does not always know just what to look for or where or how to look, the learner often profits little by observing an expert typist, tennis player, golfer or singer. Especially the child finds difficulty in seeing how the teacher writes, dances or ties a knot. To referee—that is, to observe skillfully—a boxing contest or wrestling match; to umpire a baseball game, or judge a diving or dancing contest is a fine art requiring years of experience. Were finer movements not difficult to perceive, the sleight-of-hand performer would have failed long ago. Learning by observation is difficult. It is brought about in no mysterious, instinctive or intuitive way; it is effective only in so far as the learner is able to perceive what the desirable reactions are and is then able to guide his own trial-and-error learning accordingly.

The skillful instructor should be a good actor, able to single out a particular movement and perform it alone and able to slow up a movement to afford more deliberate observation. The use of diagrams, mechanical dummies and slow-motion pictures often make possible the display of a movement more clearly than the observation of the original. There is no intrinsic advantage, because of our original nature, in any type of model. It does not matter in the least whether the model is a living movement, a picture of a movement, a lifeless copy, or what. The one criterion is the faithfulness and clearness with which it displays the ends sought. Other things being equal, that model is best which makes the desired reactions mcst intelligible and provides the most effective means of distinguishing errors and successes.

Putting the Learner through the Reaction.—In addition to the use of observation of movements and models, another form of tuition that has from time to time attained popularity consists in putting the learner mechanically through the reaction or at least in providing some mechanical guide which enables him easily to put himself through. In writing, for example, this may be done by guiding the child's hand through the letter movements or by providing letters grooved in wood or metal through which the child pushes his pencil, or by allowing him to follow with his finger the sandpaper outlines of letters, or to trace on tissue paper the forms of letters visible through it. There are two ways in which putting the learner through the reaction or mechanically guiding his progress might, conceivably, be of value:

(1) By providing a clear idea of what is to be done.
(2) By giving the mechanisms involved artificial exercise in the way they should function.

At first thought, this device would appear to provide a simply way of eliminating the errors from what would otherwise be trial-and-error learning.

What seemed, theoretically, to be the best of these devices, the tracing of letters on tissue paper placed over letter forms that were clearly visible through the paper, has been tested experimentally (Gates and Taylor). Two squads of children with about equal intelligence and motor ability but without previous experience in writing were selected. One squad practiced daily the tracing as described, the other practiced actual writing, using a model placed above the writing page. After about a month of daily practice on ten different letters, both groups were tested for several days in real writing, using only the model as guide. Some were almost completely baffled. They were familiar with the shapes of the letters, knew at what points to start and in what direction to proceed, but for them writing a letter on a blank page was a very different performance from tracing a form which showed itself through a thin paper. Some of them simply could not produce a legible letter; their consternation and chagrin was pathetic. Adults may get a taste of the confusion and annoyance which these children experienced by attempting mirror-drawing, that is, attempting to draw, or even to trace the outline of a star when the hand and paper are seen only as reflected from a mirror placed upright beyond the paper. A person may know what product he wishes to produce, but most of his efforts lead astray.

Direct practice in writing, in this experiment, was more effective than tracing. In another study (by O. E. Hertzberg) it was found to be more effective than putting the child through the reactions by means of mechanical guides. Knowledge of what to do, where to start, etc., were obtained better by direct writing. The muscular sensations obtained by being put through movements were too vague to be useful. The most significant factor, however, is this: the exercise of being put through movements or of tracing letters is not the exercise of actually writing. We are led again to an important generalization, one previously noted; *one learns precisely the reactions that are exercised.* In being put through a writing movement, the subject learns, not to write, but to be put through writing-like movements; by tracing in a groove he learns to trace in a groove, by tracing letters seen through tissue paper he learns to do precisely that. The novice who practices swimming while supported by an inflated tube, after all usually fails to learn to swim by this means alone, while learning a number of things, such as balancing on a support, which are irrelevant. There is some transfer from such artificially controlled practice—the children as a group had learned some items that facilitated learning to write—but practice of this character is usually less productive than the direct type. Except in so far as putting a learner through a reaction serves effectively to show him what the desired reaction is, such practice is of relatively little value.

The Use of Formal Exercises.—A frequently used device in learning consists in the specific practice of some element of the whole function. For example, in swimming the learner may grasp the edge of the tank and practice singly some part or the whole of the leg movement; in singing he may repeatedly do certain limited exercises; in athletics "formal" setting-up exercises are extensively used; in writing, many methods have elaborate systems of particular exercises such as repeated making up and down marks, ovals and reverse ovals, swings, loops and so on. The theoretical basis of such formal exercises is the notion that to master the whole one must master the parts, that if one learns to do singly all of the elemental acts in a complex function, putting the single acts together will be relatively easy.

This theory is quite erroneous. Learning to do the parts singly is by no means learning to do the whole. The greatest difficulties are often encountered in putting together the elements. Moreover, the elements are often already sufficiently developed without the preliminary practice; if not, they are usually more economically perfected in practicing the whole. Those which do not develop sufficiently while practicing the whole may well be handled singly later, but not until it becomes necessary.

We should not begin with elaborate formal exercise of the elements or make them a large part of the course of training but utilize them as strictly preventive measures where difficulty is beginning to appear or as remedial measures where a particular defect or deficiency is apparent.

The Discovery of Errors.—As the term "trial and error" suggests, the appearance of inappropriate reactions at all stages is characteristic of motor learning. Devices which help the identification and elimination of errors, unless they introduce other inappropriate reactions equally bad, are much to be desired. In the subtle elements of writing, speech, reading, tennis and other skills, the instructor has the double duty of being constantly on the alert for errors, usual and unusual, and of instructing the learner in the ways of detecting and eliminating his own inappropriate acts. Prevention is, of course, better than cure. Prevention may be secured to a considerable extent by giving very diligent attention to the initial stages of learning. In studies of children's first lessons in reading, it was found (by Meek) that inappropriate methods of attack, hit upon in the first endeavor to learn, may be so persistent as to make later progress difficult and the work distasteful. Such difficulties may mark the beginning of "disabilities" in reading. The cases of "disability"—children who are persistently very backward and experience extreme difficulty in learning—may be brought back to efficiency only by ingenious or extreme measures later. The procedure for treating such cases comprises the following essential steps:

(1) Diagnosis of the particular defects or deficiency responsible for the trouble. This is often an intricate task, demanding considerable insight into the particular skill as well as understanding of human nature.

(2) Making clear to the learner the sources of the trouble.

(3) By encouragement or other devices arousing a strong desire to overcome the difficulties and to achieve normal ability.

(4) Providing remedial exercises designed specifically to supplant the inappropriate reactions by effective ones.

It is very important to detect and make annoying the appearance of the old undesirable reactions and to disclose and make satisfying the new substitutes. Above almost everything else, knowledge that progress in the right direction is being made is a stimulant to further successes. In this work, as indeed at all stages of learning, the instructor or coach should constantly be on the alert for the recurrence of old or the appearance of new errors. They should be detected before they become fixed, and the proper response suggested. When an error is once eliminated, it should not be mentioned again. Emphasis should, then, in general be placed on the correct reaction; but the incorrect response should never be ignored.

The learner himself should be trained to detect his errors and successes. It is quite clear in observations even of adults in laboratory studies, that most students are unnecessarily poor learners, unnecessarily blind to their errors and successes. These deficiencies are due partly to the scant attention usually given to methods of learning. With a little attention to technique, most of us can become more systematic and more alert to our own reactions, and thus increase appreciably our ability to learn in each line. In learning to make public addresses, sing, etc., the recording of the voice, which is later critically studied, usually aids greatly the process of learning.

In other types of learning, photographic and other records may be fruitfully used.

The Directing of Attention.—In connection with these suggestions concerning the value of directing attention to and discovering errors, an erroneous theory of the value of concentration on the sensations which arise from the activities of the muscles, tendons and joints merits a word. This theory assumes that if one is attending to the sensations from the organs of response when a good reaction happens to be made, he may later reinstate the response by calling to mind the complex of sensations. As one writer puts it: "A movement idea is the revival, through central excitation, of the sensations, visual, tactile, kinæsthetic originally produced by the performance of the movement itself. And when such an idea is attended to, when, in popular language, we think hard enough of how the movement would 'feel' and look if it were performed, then, so close is the connection between sensory and motor processes, the movement is instituted afresh."

Ask a golfer what ideas he tries to activate before making a stroke. He will not say that he tries to recall the hundreds of sensations from the body that he previously felt during the process of making a good stroke. He could not possibly do so if he tried. His ideas may be thoughts of cautions such as: "Now, don't get excited," or "Take your time," or "Keep your eye on the ball." As for the expert, the less he thinks about how he feels or how it felt to make a good stroke, the better. He simply makes the preparatory reactions—adjusts his feet, bends his knee, places the club, and goes through with the stroke with no thoughts of the movements whatsoever.

The whole notion that a learner profits by attending to the sensations from the members employed in a complex act is erroneous. Attention should be directed to:

(1) The features which assist in securing the correct preliminary orientation.
(2) Features which help in detecting errors or successes in the act.
(3) The general outcome of the act.

If one is trying to throw a baseball over the plate, he must first observe and thereby locate the plate. When the movement is under way it is wise to look at the plate, although at times—in practice—it pays to give attention to some part of the process which is troublesome. Thus, the pitcher may be stepping out too far; an error which he must detect and remedy. He should know both when his moves are incorrectly and when they are properly performed. As soon as he gets the act going right it is better to think about it no longer. The other feature which deserves attention is the outcome of the total act: the pitcher should try to observe accurately just where the ball went, and try to account both for successes and errors.

The same principles hold for other forms of motor activities. In writing, drawing, carving, diving, turning handsprings and so on the learner must first get the correct position, and second, keep on the lookout for good and bad movements by watching the product, trying at the same time to detect the causes of errors and successes. As he masters the act, the conscious reactions gradually drop out because they are unnecessary. Nowhere does the attempt to get an idea of how a movement feels contribute anything useful to the production of the movement.

Summary.—The positive suggestions for economy in motor learning are the following:

(1) Make a real study of the characteristics of the function that is to be learned. For this purpose may be utilized

(a) verbal descriptions,
(b) direct observation of good performers or, usually better,
(c) pictures—especially slow-motion pictures—graphs, or other mechanical aids.

(2) Make a real study of your own reactions as you learn. Develop ability to compare your own detailed acts or products with those of others and thereby detect and remove errors, select and practice successes.

(3) Do not depend upon formal exercises of parts of a function except where the part offers unusual difficulty; on artificial exercise obtained by being put through a reaction except as a device for assisting observation of the form of the reaction; on the muscular and kinæsthetic sensations. When in doubt as to the value of some unusual device, recall the principle: *one learns exactly the reactions he practices.*

PRINCIPLES OF GUIDANCE IN THE ACQUISITION OF INFORMATION

Learning Information Is Acquiring Reactions.—It is of utmost importance to realize that the acquisition of information or the learning of any fact is as definitely the result of one's reaction as is the learning of any motor act or skill. Unfortunately it is frequently assumed that facts are learned and ideas acquired as the result of passive absorption. It often appears that we observe what the environment impresses upon us; and that ideas just come to us of their own initiative. The fact is, however, that in observing a thing or event, or in acquiring a fact about a situation we react just as definitely as in tackling or avoiding an opposing football player. In learning to recognize a football player before the game, one learns reactions just as definitely as one learns in practice to react by vigorous dodges and "straight arms" to the player's tackle. Finally, there are as many different forms of reacting which result in mere recognition of "Right Tackle Bill Jones" as there are types of evading Bill Jones's tackle.

Suppose we attempt to discover just what we learn in a particular case. Get a colored picture of a farmhouse or any other scene. Invite several others to study it with you for 30 seconds, after which each one is asked to write out a full account; or, better, to attempt to answer a number of questions asked by an additional person holding the picture. It will at once be discovered that no one has mentally photographed the picture; no one finds that the picture has so impressed itself upon him that the details may be seen as if the picture were really there. On the contrary, few can give such details as the number of windows in the house; the number of clouds in the sky, etc. One striking result is that even if all observers recall about equal amounts, which is very unlikely, they have learned different items. Obviously the process of learning, here, is not mere passive impression. The individuals learned, *i.e.*, remembered, only those items to which they reacted. Occasionally, a listless observer stares at such a picture—the full image of it being formed on his retina—without consciously, actively reacting to it at all, and he may therefore be unable to recall any details, although he may guess a few correctly if the picture is to some extent like pictures he has seen before. Different people learn different things because they react in different ways to different items, but without reaction nothing is learned.

What Is Learned Depends upon How One Reacts.—In the acquisition of information, great difficulty has come from the notion, often accepted in practice if not in thought, that a fact is a fact, and it will function without regard to *the way in which* it is acquired. It is often assumed that if multiplication tables, vocabularies, or names and dates in history are thoroughly learned, it matters little how they are learned. This is completely to disregard the fact that what we learn in these cases is not subject matter but, as elsewhere, particular reactions. We have added to our equipment certain responses which can function only in certain ways—ways determined by the manner of learning.

The first principle, already mentioned under motor learning but especially needing emphasis here, is this: we learn the reactions that we make. An investigator (Myers) once asked a large number of students whether the four on their watches was a IV or a IIII. Of 200 students whose watches carried a IIII, 179 declared it was IV. In spite of the fact that they had looked at their watch faces hundreds of times, very few had made the specific kind of reaction to the IIII which would enable them to recall it as such. Similarly 192 reported that six o'clock was indicated by VI, when as a matter of fact there was no numeral at all at that hour. In another investigation, the experimenter told classes of college students that he wanted to test their ability to spell a list of words. When the six words had been written and the papers collected, the students were asked to write again the six words in the order given. Of 236 students, only five per cent recalled all of the words in the proper order; twenty-five per cent could recall the words but not the correct order, and five per cent could remember only half of the words and then were uncertain of the order. The explanation is that, having heard a word, to write its spelling is one kind of reaction, while to memorize a list of words in their order demands a very different kind of reaction.

How One Reacts in Learning a Vocabulary.—In another case, the facts are illustrated more clearly. A student in the course of some statistical work found it necessary to use the squares of numbers from 13 to 30. Using a table which gave these numbers and their squares, the reaction—think of the number, find it on the page, look at the square, write it down—was made several hundreds of times for each number in the range; but afterwards upon test it was found that only five squares (those of 13, 15, 20, 25 and 30) could be instantly recalled. If a different reaction—roughly, think of the number, then think of its square—had been exercised specifically, all the squares could have been memorized in a short time. In the first case, the ability to find numbers and their squares had doubtless improved greatly by use; but the reactions required for recall had not been specifically exercised and consequently were not acquired.

Consider the learning of a vocabulary which is given in the book as follows:

(1) *Der Mann*—the man,
(2) *Der Knabe*—the boy,
(3) *Der Hund*—the dog,
(4) *Das Haus*—the house.

Suppose that a student learns the vocabulary by reading the pairs, one after another, in the order given. What connections are formed? Bonds between the pairs and their position in the series are made, and are especially strong in the case of the beginning and end of the list. Thus, *Der Mann* is connected with its firstness, *Der Knabe* with secondness, etc. Bonds between the first pair and the second pair, the second and third, etc.—that is, serial connections, like those acquired in learning a series of non-sense syllables—are also formed. Strong connections between the end term of one pair and the beginning of the next ("man"—*Der Knabe*, and "boy"—*Der Hund*) and between the various end terms ("man—boy—dog"—etc.) are also established. Upon such connections as these the reaction may largely depend. Now, suppose you ask the student to give the equivalent of "house"; or suppose *Der Hund* is written alone on the board. He may fail to make the correct responses in both cases although he could say the whole list as he learned it. It is somewhat like asking a person to give immediately the letter which precedes "q" or "o"; unless he has previously practiced just such reactions, he must get the answer in some roundabout way.

One must learn precisely the reaction that will be needed for practical purposes. Usually, we study the German-English vocabulary so that later, on seeing the German word in isolation or in various contexts we can react with the thought of its English equivalent. A good method of learning, then, would be to take small cards and to write on one side the German word, on the other the English. Shuffle several such cards in order to avoid forming the serial, position and other irrelevant bonds. Look at the German word and try to recall the English equivalent. This demands the reaction that one will later be called upon to make.

Reactions in Learning by the Part and the Whole Method.—If a person were given an assignment of substantial length, he might either study it part by part or as a whole. The "part" method means learning such sections as stanzas or paragraphs one at a time; the "whole" method means going through the whole assignment from beginning to end until it is mastered. Various experiments have shown that in memorizing such materials as poems of from 20 to 240 lines, and prose selections of similar length, the whole method usually shows to advantage with respect to the amount of time or average number of repetitions required to reach a stage of accurate recall. A sample result is shown in the following table:

WHOLE VERSUS PIECEMEAL LEARNING OF POETRY
(From Pyle and Snyder)

NUMBER OF LINES	PART METHOD TIME TO LEARN	WHOLE METHOD TIME TO LEARN	PERCENTAGE OF TIME SAVED BY WHOLE METHOD
20	16′ 12″	14′ 17″	12
30	27′ 23″	23′ 53″	13
40	38′ 44″	35′ 16″	9
50	48′ 31″	43′ 53″	12
60	81′ 10″	63′ 38″	22
120	168′ 55″	139′ 35″	17
240	431′ 20″	348′ 00″	19

Note that in this table the whole method resulted in a large saving of time; on an average, the saving is fifteen per cent. It may be observed, too, that the saving of time for the longest selections is greater than for the shorter ones.

The whole method has often shown its superiority even more conspicuously when the test is the amount of the material that can be recalled after an interval of time. The following table shows such a result.

RECALL OF POETRY LEARNED BY PART AND BY WHOLE METHOD
(From Larguier des Bancels)

	LEARNED BY WHOLE METHOD	LEARNED BY PART METHOD
Number of words recalled after one week	40.6	26.6
Number of words recalled after two years	16.6	6.4

After one week, the number of words recalled after learning by the whole method is related to the number recalled after learning by the part method as 100 to 63; after two years the ratio of whole and part is 100 to 39. While such ratios tend to exaggerate the differences, they indicate that the whole method's superiority is greater when the test applied is a measure of permanence of learning.

Several factors are probably responsible for the superiority of the whole method of memorizing such materials. The chief factor probably is the different type of reactions which the whole method is likely to produce. It usually produces more vigorous reaction: the longer assignment is more of a challenge to alertness. The part method lends itself more readily to superficial study. The sectional method seems more likely to induce the learner to depend upon rather artificial connections such as those with position in each stanza. These connections may later be the source of confusion, since the first lines of several stanzas are recalled on the basis of being in first position. The part method introduces, also, certain misleading connections. For example, when the learner completes the reading of the first stanza, he goes back to the beginning of the same verse and reads it until this part is learned. The result of this procedure is that the end of this stanza, instead of being connected with the beginning of the *next* stanza, is connected with the beginning of itself. You may have noticed that children in "speaking pieces" often get stuck at the beginning of a stanza which they can recite readily once they get started. On the other hand, the whole method practices only forward associations. It tends also to induce the learner to react to less artificial factors such as the meaning of the poem as a whole, the development of the thought, the recurrences of ideas and the like. In general, the whole method has the advantage of requiring the learner to react during study as he will react when he recites. Thus the connections are formed in the way they will later need to function. The superiority of the whole method, then, is another illustration of the general principle that one learns the reactions one practices.

The whole method shows to advantage in memorizing poetry, prose, vocabularies, lists of words and non-sense syllables—and probably in most materials which are to be memorized in serial order. In learning by reading (history, etc.), the relative merits of whole and piecemeal methods have not as yet been demonstrated, but it is probable that reading a lesson through as a whole is distinctly advantageous to reading and re-reading only the parts.

Either in memorizing or reading, the whole procedure should not be adhered to slavishly. Difficult and important sections should be given more attention: easy or unimportant matter "skimmed."

Now that we have introduced the whole and part method we will have to carry the discussion a little further to avoid leaving misleading impressions that the whole procedure is superior in every function for every person.

Complicated dance steps, musical selections to be played or sung and many industrial operations fall within the serial type of learning which may be practiced as a whole or in parts. In an inventory of methods actually used by one hundred prominent musicians, fourteen reported that they employed the whole method exclusively, another fourteen combined the whole and the piecemeal procedure, while the remaining seventy-two learned mainly bit by bit. These data throw little light on the merits of the methods inasmuch as highly competent performers in every field often employ uneconomical methods. Crucial investigations in the case of such functions are lacking. Theoretically, the whole method would seem to possess the same merits here as in the case of memorizing poetry or prose. One investigator (Peckstein) found, however, that in learning certain motor acts, such as tracing the course of a complex pencil maze while blindfolded, the whole method was uneconomical. When the task was extremely difficult, subjects were sometimes unable to learn at all by the whole method.

The last study and certain others show that there are certain exceptions to the rule that the whole procedure is better than the part. It often works poorly in experimental studies when tried for the first time by persons long accustomed to piecemeal methods. They are sometimes frightened by the task; it seems impossible ever to learn in so unaccustomed a manner. The situation is similar to that produced by asking a person to change his method of typing or reading radically. The better method has to become habitual before its full advantages are realized. However, our main concern at the present time is merely to show that in most functions, persons who have acquired the knack of learning by a whole method, modified to accord with variations in the difficulty among parts, realize greater efficiency in learning and that this advantage is due chiefly to the fact that the whole method, better than the part, puts into effect the principle of learning by reacting in the way one will later be called upon to react.

Reactions Called Forth by "Reading" and "Recitation" Methods of Learning.—In one investigation two general methods of reacting were tested in the course of memorizing materials. One method consisted of reading and re-reading a list of sixteen non-sense syllables (or a group of five short biographies totaling about 170 words) without looking up from the paper. Another method consisted in beginning at a signal to recite—that is, to attempt to recall when not looking at the material—prompting oneself speedily by glancing at the paper when unable to proceed. The latter kind of reaction is just the kind that will be demanded later. The question is, does exercising as soon as possible the reaction that will eventually be demanded result in more economical learning and retention than the method of reading and re-reading? The "recitation" method turned out to be quite superior, as is shown by the accompanying table. A study of the table will disclose several facts: (1) The greater the amount of time devoted to recitation, the greater the percentage of the lesson recalled. Of course, some time must be spent at the start in reading the material. After a few readings the process becomes partly recitation; that is, one skims over the items that are familiar, seeing a bit here and there and filling in the gaps by recall. This is true of the ordinary reading of most adults. This explains (2) the fact that one does better relatively, in learning sense material by reading and re-reading than in learning non-sense words which, to begin with, contain fewer meaningful associations which make recall during ordinary read-

RECITATION VERSUS RE-READING
(From Gates)

MATERIAL STUDIED	16 NON-SENSE SYLLABLES — PER CENT REMEMBERED		5 BIOGRAPHIES = TOTAL OF 170 WORDS—PER CENT REMEMBERED	
	Immediately	After 4 Hours	Immediately	After 4 Hours
All time devoted to reading.	35	15	35	16
1/5 of time devoted to recitation.	50	26	37	19
2/5 of time devoted to recitation.	54	28	41	25
3/5 of time devoted to recitation	57	37	42	26
4/5 of time devoted to recitation	74	48	42	26

ing possible. (3) The recitation method results in the learning of a different group of reactions, the kind that makes for more permanent retention, as indicated by the fact that the greatest superiority is shown in the columns of the table which give the percentages remembered after four hours.

A Guiding Principle in Determining How to React.—As pointed out previously, a fact may be learned in several different ways. The best way is to learn it in exactly the form that will be used later. The first guiding principle, then, *is to consider the situation which life will present and so arrange the circumstances of learning that the learner will secure experiences in making those reactions which will be demanded.* This is precisely what the student does when he learns by recitation. He gradually forms and practices the reactions just as they must be exercised in recall at a later period. Another advantage of the recitation method is the fact that during learning one discovers just what parts are especially difficult or easy, and distributes his energy accordingly. He finds what kinds of associative aids work and what kinds do not. Finally, the learner is aware of his progress during active attempts at recitation. In the re-reading method, some were uncertain as to whether they were mastering the lesson or not; the learning becoming very irksome on that account. During recitation the learner is stimulated and encouraged by the awareness of making progress; and clear evidence of success is a great motive in learning.

Selecting the Type of Reaction Mechanism.—It was stated that in acquiring information, one should practice the reaction in the way it is to be used in life, since what is learned is not an entity which we call a fact, but a particular reaction. In this connection, the question has been raised as to whether we may not be so organized by original nature that reactions made by some mechanisms are more readily acquired and more permanently retained than when made by others. To illustrate: one may practice spelling a word mainly by articulating it, by writing, typewriting, tracing in the air with an arm movement, by moving the eyes or—eliminating these external expressions—by imagining its visual appearance, or by "hearing in the mind's ear" the sound of the letters. Which is the best way? So far as the evidence now available goes, the neural connections concerned in one type of reaction appear to be as modifiable as those concerned in others. We may, to be sure, form habits of learning our spelling in one way or another, of learning facts from a lesson, or acquiring names, dates and telephone numbers by visualizing, saying them to ourselves, saying them aloud, or writing them on paper and find that we are less efficient if not permitted to learn in that way. The reason in all probability is that such is our habit, associated with it are our particular techniques of learning. Any new method is likely to prove troublesome for a time. Consequently, we may still hold to the dictum: Learn the act in the way it is to function in actual life. For most of us, learning to spell by means of actual writing, therefore, would be preferred, although oral spelling might be acquired quite as easily. If we are learning a poem to recite, it would be better to recite it aloud while learning; if learning it merely to recall in thought, then reciting inaudibly is quite as good.

Selecting the Sensory Avenue of Presentation.—Similar to the problem of the use of the model in motor learning, is the question of the relative values of different sensory avenues of presentation, in the case of informational learning. Are we by original nature so constituted that we acquire most readily through the visual, auditory, tactile or some other sensory avenue? So far as we know, the primary and higher neural connections of the brain aroused through one sense organ are just as modifiable and retentive as are the centers stimulated by others. Other things being equal, we learn quite as readily through one sense as another with the exception, of course, of individuals whose receiving, connecting or central mechanisms are defective. Other conditions, consequently, determine which avenue of presentation is to be preferred. Very young children learn new words better, for example, when they are presented to the ear than when presented to the eye, for the reason that their early word experience is auditory and not visual. If they have attended school, by the average age of eight or thereabouts children memorize better material presented visually. This is mainly due to the fact that during reading the child can regulate the speed of reacting to the words to suit his capacity; he can attempt recall when and where he pleases; he can stop and repeat the especially difficult items, and disregard those already mastered. The differences depend on experience and methods rather than on intrinsic differences in the neural connections involved.

The relative values of moving pictures, graphs, diagrams, mechanical instruments, verbal explanations and clay models are similarly determined by past experience and mechanical advantages. The main questions are: which method makes most clear the thing to be learned and which does it most interestingly and most economically of time, space and money. Original nature is not so organized that we learn pictures better than words, or graphs better than models.

Formal Exercises and the Use of "Crutches."—Since we learn those reactions that are exercised we should be skeptical, in informational as in motor learning, of preliminary and formal exercises and of "crutches" or extra material introduced to facilitate one or more steps in the process. Many of the commercial memory training courses consist mainly of both of these types of devices. Under formal exercises they include everything from deep breathing and dumb-bell exercises to the learning of series of names, dates, letters, facts, on the assumption that the "power of memory" is thereby trained as a whole. The fact is that the ability to memorize any kind of material must be improved through systematic practice on that kind of material. If our purpose is to improve our ability to memorize facts in chemistry, the early morning breathing and dumb-bell exercises will probably be nearly as useful as exercises in learning combinations of digits. Neither will assist much.

The term "crutch" originated in the school and refers to the temporary use of a device to assist the pupil more rapidly to master some difficult task or topic. Adding or subtracting, at first, by counting on the fingers, writing the number to be "carried" in long addition, at first, to avoid forgetting it, writing the sign + or − or × to guide the child in computing, are samples of crutches used in arithmetic. These practices are quite similar to the use of inflated tubes in learning to swim, or tracing grooves in teaching writing. While they may often provide temporary aid, they often produce greater difficulties than they relieve. The objection to them is that they represent the formation of habits that later must be broken. It is sometimes more difficult to break the habit of adding by counting, once it is learned, than to have learned really to add in the first place. Certain crutches may, however, on occasions be useful and they may be employed safely to smooth a difficulty, provided they are supplanted by the proper procedures before they become habituated. In general, such devices are to be considered a last resort and then to be used with caution.

The principle of crutches is essentially the same as the principle inherent in various memory "aids" or mnemonic systems of which a simple form is the familiar rhyme "Thirty days has September," etc. Like other crutches, mnemonic structures may occasionally be useful, especially where the facts, like the number of days in the several months, are difficult to learn because they are readily confused. But, like other crutches, these devices are of limited utility. The most complex ones are rarely useful. The most competent learners, those professionally engaged in acquiring information, such as historians or mathematicians, rarely use such devices. They find that, in the main, they merely add something to be learned in addition to the facts.

The Discovery of Errors.—Tests of ability in language usage, spelling, arithmetic, or of ability to recall verse or prose previously learned, or facts previously studied in any field usually disclose an abundance of errors. College students tested at the completion of a lecture in psychology for facts presented during the hour (by Jones) made on the average, from 30 to 40 per cent incorrect statements. The recall of facts contained in a chapter read once carefully will be as erroneous. Such inadequacies of memory after a single repetition are to be expected, of course, but a difficulty lies in the fact that learners too frequently fail to realize which items are erroneous and proceed to practice them in further study or recall. Thus, like errors in speech and spelling, incorrect information becomes firmly established and difficult to dislodge. What one does thereafter is to practice errors.

In Chapter I were given illustrations of the extremely erroneous character of the observation and reports of professional men. The recollection of materials read is quite as erroneously reported. One of the most notable characteristics of the results of recent "standardized tests" in various fields of knowledge is the amazing number of errors that are complacently made. Students from kindergarten to college seem to assume that to make numerous errors is quite the proper thing. It is apparently the "normal" thing; but it is also a serious thing. Even the errors that occur as "slips" or "lapses" are serious. An illustration of the seriousness even of occasional errors is well illustrated by a study (by Myers) of a child, who after having presumably learned that 4 + 6 = 10, slipped one day, by reacting 4 + 6 = 8. Myers followed up the child's succeeding reactions to 4 + 6. They were as follows: 8, 10, 8, 10, 10, 8, 10, 10, 10, 10, 8, 10, 10, 10, 10, 10, 10, 10, 10, 8, 10, 10, 10, 10, 8, 10, 10, 10, 10, 10, 10, 8, 10, 10, 10. Although the 8 was at first a mere slip, it was as definitely a response to 4 + 6 as 10 is or was. What is more, the response 8, despite showing a decreasing frequency, is extremely persevering. After making the "slip," the pupil is uncertain in his response as long as he was observed. If errors in recognizing chemical symbols in the drug store, or in checking the times and tracks for trains in the watchtower, or computing distances and forces in engineering, made but once, tend to recur like the 8 in the observations above, their seriousness is apparent. Then seriousness of errors in general lies in the fact that they *recur*. Errors which recur may be the basis of more serious errors.

Studies of difficulties in arithmetic (by Buswell and John), in algebra (by Symonds) and in other subjects have shown how an error in a lower step such as 4 + 6 = 8, becomes the fundamental source of all sorts of trouble on higher levels. Thus it was found in arithmetic that serious and discouraging difficulties in the higher operations often begin with exactly such errors as 4 + 6 = 8. In algebra it was found that a few such errors in fundamental operations often resulted in complete failure in the subject by pupils of excellent intellectual endowments. The writer has found that similar "slips" are sometimes the cause of serious difficult or complete inability in learning to read. There are good reasons for believing that such serious functional errors as stuttering or stammering sometimes begin as more or less accidental errors that not only recur like 6 + 4 = 8, but being more embarrassing, occasion disturbances that make them worse. Probably many of our individual follies and prejudices in the realm of information have equally innocent beginnings. Let us therefore give a little attention to the matter of "lapses" into error when "we know better."

Errors and Inhibitions in Recall.—Every one has had the experience of misspelling a word, miscalling a name or writing a wrong fact during an examination, when the item itself was really well known. These errors we call "slips" or "lapses" but there is always a definite explanation for them whether we may readily discover it or not. They occur in the motor field, too, as when we "muff" an easy ball, drop a cup or make a misstep on the stairs. They are due to a preceding or simultaneous activity of a sort that predisposes or adjusts the neural mechanism to react in a different way; some stimulus or attitude usually subordinate has become prepotent. Thus if I am writing the sentence "This is the way to write the word," and begin the "w" in "way" just as I think of "word," I may write "word" instead of "way." The thought of "word," at the moment of writing "way" usually remains subordinate, but occasionally it may get the better of the other impulses. In writing this sentence, another frequent error consists in the substitution of "write" for "word." This error is due to the perseveration of the effects of the recent writing of "write."

These misleading tendencies appear more clearly on those occasions when a person is blocked in attempting to recall a familiar item, a name, telephone number or a poem. In such cases, to quote William James, "The state of our consciousness is peculiar. There is a gap therein; but no mere gap. It is a gap that is intensely active. A sort of wraith of the name is in it, beckoning us in a given direction, making us at moments tingle with the sense of our closeness, and then letting us sink back without the longed-for term. If wrong names are proposed to us, this singularly definite gap acts immediately so as to negate them. They do not fit into its mould. . . . The rhythm of a lost word may be there without a sound to clothe it; or the evanescent sense of something which is the initial vowel or consonant may mock us fitfully, without growing more distinct. Every one must know the tantalizing effect of the blank rhythm of some forgotten verse, restlessly dancing in one's mind, striving to be filled out with words." What may one do in cases like this to facilitate recall?

The cause of such failure of recall is often the same as the cause of wrong recall, indeed, in most cases we do recall things that are recognized as erroneous. The cause is the prepotency of some inappropriate response and the relative weakness of the right one. In any case the difficulty is due to an interference of an inappropriate with the usual associative connection; some preceding or simultaneous tendency of thought or a sudden stimulus such as fear, excitement, stage fright, loss of confidence may introduce interfering elements. The best method of procedure in such cases is first to search for clues while trying to regain confidence. Instead of allowing one's self to become confused, eliminate the fear before it gets started by "substitute activity"—by plunging into an active search for clues. If it is a forgotten name, look the person over, recall his business, his friends, where you met him, etc. If it is a fact not forthcoming during an examination, confidently review related matter, recall when and where you have previously used it. This procedure utilizes the advantages of facilitating stimuli; perhaps ever so slight an additional clue will cause the item suddenly to appear. If these maneuvers fail, the best policy is to dismiss the matter and turn to other things, go on with the remainder of the examination. The interfering factors are usually temporary mental activities or tendencies which subside more or less promptly. If the fact cannot be recalled during a vigorous second trial following a rest, allow another period of inactivity. If the fact is not really forgotten—which it often is, of course—sooner or later the interferences will have been swept away, leaving the appropriate associations unmolested.

In motor performance the difficulty analogous to erroneous recall sometimes occurs in the form of loss of control. In typewriting or tennis, one may "go to pieces" in some degree, constantly making errors of one or more types. The explanation of these errors is the same as that for erroneous or blocked recall: some interference with the neural operations. The remedy is also the same: try hard, and above all, try confidently to regain control; don't allow yourself to become discouraged or angry. If mastery cannot be regained in this way, it is better to drop the task for a time, since to continue would be to practice errors.

Summary.—Most of the suggestions for effective informational learning or memorizing are contained in the following summary:

(1) Learning is an active process. We learn those reactions that we practice. Hence the attack should be vigorous and the reaction should be actually the one later to be desired. We should practice actual recall and use of facts to be mastered.

(2) Since facts are learned through one sensory avenue as well as another, utilize the form of presentation which is mechanically most convenient.

(3) Since the central neurones concerned with one form of imagery or motor mechanism are natively no more modifiable than another, practice—in spelling, memorizing poetry, etc.—that form of reaction which will be later demanded.

(4) Use formal exercises, crutches and other mnemonic devices sparingly and never unless some special reason for them exists. Avoid learning irrelevant materials; avoid forming habits that must later be broken unless the temporary return is obvious and great.

(5) Diligently test recall for errors. Try to detect mistakes before they are "stamped in"; avoid practicing erroneous reactions.

(6) Give the child guidance as needed to enable him most fully to manage and appraise the entire process of learning and using information. Help him not only to learn and use facts but also to learn how to learn and use them.

(7) When recall is blocked, try to adopt an active and confident attitude. Search for associated clues. These devices failing, drop the subject for a time before trying again.

In the last few pages we have suggested three things to do: (1) In every form of learning give the child a good idea, a good model, of what is to be done or learned. A pupil learns most laboriously, or not at all, unless he has an idea of what is to be learned. (2) Introduce devices that enable the learner also to see when his learning is progressing properly and when it is going astray. Don't let the immature learner *practice errors*. (3) However, in order to accomplish the results mentioned in (1) and (2), that is, to provide a model, and guidance and a means of checking up on successes and errors, don't introduce highly artificial mechanical aids that themselves make the exercise of certain essential reactions impossible or that introduce unessential or harmful habits that must be broken later. One of the greatest difficulties in a practical situation is to appraise a suggested device. For example, consider the following procedure suggested (by Reeder) as a means of guiding children's study in geography.

Illustration of a Form of Guidance in Geography.—Each pupil is provided with a geography textbook and a series of exercises. He is told to do all of the exercises after having read and reviewed the text as seemed to him advisable or necessary. The following is a sample of the exercises which were provided for one assignment.

STUDY QUESTIONS

Sections 406 to 413, pages 210 to 214, in the text tell about the Green Northlands of Europe. Paragraph 406 tells what the principal industries of this region are. Write them here.

.................................and................................

Why are these the industries of the Green Mountains? Read from section 406 through section 413 with that question in mind. Read these sections twice. Then see how many of the questions below you can answer. After you have answered all you can, find the answer to the others in the book.

1. Write below the names of the islands which lie between Scotland, Norway and Iceland.

.................................and................................

2. Underline the best reason why the land in this section is used chiefly for pasturage.

(a) There are many cattle and sheep there.
(b) The islands are covered with snow in winter.
(c) The islands are too wet to plow in summer time.

3. Fill in the blank spaces.

(a) Partly because of the fact that this region is not suited for agriculture, the chief industry of the people is............ (look at the picture on page 210)..........and.......... are salted and dried for export. The people's houses are made of..........and have..........roofs.

4. Underline the best title for section 407.
(a) Summer tourists in northern waters.
(b) Why northern waters near Europe are warmer than those near North America.
(c) The Gulf Stream.
(d) Ocean currents of the Atlantic Ocean.

5. Cross out the wrong words.

(a) Ocean currents make the lands we are studying $\left\{\begin{array}{l}\text{warmer}\\ \text{colder}\end{array}\right.$ than they would otherwise be. The Gulf Stream flows from the Caribbean Sea and the Gulf of Mexico $\left\{\begin{array}{l}\text{northeast}\\ \text{northwest}\end{array}\right.$ across the $\left\{\begin{array}{l}\text{Atlantic}\\ \text{Pacific}\end{array}\right.$ Ocean. The current has $\left\{\begin{array}{l}\text{twice}\\ \text{ten times as much}\\ \text{1800 times}\end{array}\right.$ water as the Mississippi River.

6. Put a T before the sentence below if it is true and an F if it is false.

(a) ....The ports on the eastern coast of Siberia are open longer than those on the western coast of Norway.

7. Fill in the blank spaces below with the words "water" or "earth." Be sure to put the right word in the right place.
(a) ....heats more slowly than..........
(b) ....cools more slowly than..........
(c) ....is warmed to a greater depth than..........
(d) ....holds its heat a shorter time than..........

Now the question is: Should exercises such as these be considered as mechanical aids or crutches which hinder more than they help? Do they lead the pupil to react erroneously? Do they form habits that must be broken later? The geography exercises were designed to indicate the kinds of reactions that are believed to be desirable for the pupil to make during his study. Correctly to do the exercises the pupil must detect the important facts, observe the relation of one fact to others, and the relation of various items to certain general problems. The pupil must read selectively and sagaciously; he must think and reason with the facts in the passage. Now, these are exactly the reactions that life demands of competent readers. The exercises do not do the work of thinking for the pupil as the grooves control the movements in writing. They do not give the pupil exercise in reactions that are quite different from the natural function. On the contrary they are arranged to suggest the ways in which geographic material should be sorted out into important and unimportant and used in solving various problems.

Exercises like those tried out by Dr. Reeder proved, in investigations conducted in regular classrooms, to be highly efficacious. The pupils liked to study with them and they learned not only more facts but acquired better techniques of manipulating, thinking and reasoning with the data. The exercises, like the copy in writing, served as a kind of model of good ways of working. By completing the exercises, moreover, the pupils could readily determine what facts they acquired and what ones were overlooked or distorted. They could discover not only how well they had mastered the material in general, but also in what particulars their knowledge was deficient, hazy and erroneous. They were able also to test their powers of applying the facts. These devices made their work not only more efficient, but also more enjoyable. But, like any other good thing, such devices may be overused. Children may be led to become so dependent upon exercises that they are less efficient when they are not provided. Additional experience in making up his own problems and of guiding his study without any such aids should be provided for the pupils after the use of ready-made exercises have sufficiently served as models. Properly employed, practice with such exercises paves the way for establishing independent skills in study and thinking.

Acquiring, Testing and Using Information in Reasoning, Problem Solving, etc.—We have suggested that it is of great importance to guide the child in learning; to give him models of desirable reactions; to help him to appraise his own reactions, whether motor or intellectual, that is, to acquire ability to detect his own successes and errors. The methods of asking and answering questions of fact, skimming the reading matter which expressed the facts, recalling the facts in outline, etc., are the simpler devices. There are ways of doing the same things in the course of more elaborate mental activities such as those comprising the application of the facts to new situations, the use of the facts in complex forms of thinking, problem solving, imagining, reasoning, conducting experiments and projects. By testing the validity of information, by using it in these more complex projects, children really kill two or more birds with one stone. Not only do they test the validity of their learning up to that point, but they also extend the mastery of the facts and—what is of greatest importance—they also learn to reason, judge, imagine and otherwise utilize and apply the facts. These methods are of such supreme importance that, instead of attempting to describe them here in brief form, we shall devote three entire chapters to them. Here we shall only state the general principle, which is: *Children should receive guidance as needed to enable them most fully to manage and appraise the entire process of learning and using information and skill.*

When we say "as needed" we mean to imply that pupils should be given no more and no less guidance than that which enables them most fruitfully not only to learn and use facts but to learn how to learn and how to utilize them without guidance.

QUESTIONS AND EXERCISES

1. Does insight into methods of learning and the detailed operations during performance necessarily result from the possession of great skill in a function? Can you recall instances of great athletes, musicians or artists who were poor teachers? Are fine scholars necessarily good teachers? Are they more or less likely than poor scholars to be good teachers?

2. Explain just what you do when you whistle. Study your vocal organs while whistling to see if you can learn facts about the activities involved that were not known by you before.

3. Apply the facts given in the text to the teaching of some athletic or recreational skill. Compare with methods you have observed in use.

4. Criticize the use of phonetic drill in a separate period devoted to analyzing the sounds of words as a means of increasing a pupil's ability to recognize unfamiliar words during the course of reading.

5. Criticize the use of "flash cards" that is of large cards of printed words that are "flashed" to view and quickly removed as a means of increasing the span of perception of words in ordinary reading.

6. Which is better practice for the varsity crew, rowing in indoor machines or rowing on the water? Explain. Which is better practice for the baseball team, practicing catch, grounders, batting, etc., separately or when playing actual games? Explain. Aside from playing actual games, what supplementary work is desirable? To what extent will throwing baskets in basketball from a stationary position increase ability to toss baskets during active competition?

7. Explain why learning to read German does not enable one to write it or to understand spoken German. Would it be wise to learn in one way or another according to our need to read, write, speak or understand it when spoken?

8. Why is it that some people have difficulty in understanding a passage when they read it aloud to a group?

9. Why is it that a person's voice often sounds quite different when (a) reading aloud, (b) reciting, (c) conversing?

10. How would you teach a child to write better English compositions? Show how the principles offered in the chapter apply. Would it be worth while to have the student read or copy good compositions written by others?

11. Can you offer any example of the use of "crutches" in the teaching of school subjects.

12. Would you present in the spelling lesson the common misspellings of difficult words along with the correct form? Would you say to a child, "You wrote *meashure*. The correct spelling is *measure*," or simply say the word was misspelled and give the correct form?

13. Try this experiment on three different groups. Ask them to guess the length of time which passed between signals. You will say "Ready!" and in a moment "Now!" Then allow an interval of 10 seconds, at the end of which you again say "Now!" The members of the group then write their estimate of the interval in seconds. Repeat with other intervals such as 6, 8, 15, 14, 10, 18, 9, etc., until 30 trials have been made. With a second group, use the same intervals and the same number of trials, but after each trial say: "The time was more than 10 seconds" or "less than 10 seconds" as the case may be. To a third group, state the exact length of the interval after each trial. Compute the improvement for each group. Compare and explain the results.

14. Should the writer attend to the feelings in the fingers or the written product? The singer to the "feel" in the throat or to the vocal product?

15. Should the learners be taught to criticize themselves? Why? How may this be done?

16. Taking into account the facts concerning recitation vs. re-reading, the distribution of intervals in learning and review, the whole vs. the part method of study, plan the most effective method of study for this course in psychology.

17. Can you see any advantages in taking but few notes during a lecture and writing out a full account later, in comparison with taking very full notes during the lecture and reading them over later? Could you test these or other methods experimentally?

18. Can you illustrate from your experiences the seriousness of accidental errors and the difficulty of getting rid of them?

19. Appraise the values and limitations of such exercises as these in studying psychology. Of what value would be the practice of having each student make up objective examination questions and of testing each other with them.

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CHAPTER XI

UNDERSTANDING AND GENERALIZING

In the two preceding chapters, in which the characteristics of the development of a fact or skill were traced and some of the principles of guiding the learner in the simpler forms of practice were explained, it was apparent that what may superficially appear to involve little more than "drill" or memorizing, may and often does enlist the higher mental processes of analysis and reasoning as well. Modern educational practice especially seeks to utilize, encourage and develop both interest and ability in independent thinking, problem solving, reasoning, imagination and creative achievement. It seeks, moreover, to do more than merely develop ability to think and reason in arithmetic or grammar; it seeks to produce skills more widely applicable, to develop abilities to reason in the situations of life whenever encountered and whatever the type. In considering these forms of learning, three general problems are encountered. The first problem deals with the factual data, the "ideas" or "concepts" which are used in thinking, and the ways in which the substance of thought is acquired. We must answer the question: How are ideas and concepts usually acquired, and how may they be most economically and effectively developed? The second problem is concerned with the mechanics or technique of thinking, reasoning and problem solving. Here we shall try to answer the questions: How do we think and how may we improve our thinking in a particular field? The third problem concerns the general effects of specific training.

Here will be encountered such questions as: If children are taught effectively to study, to reason, to exercise initiative and originality in grammar or arithmetic, to what extent will this training carry over or transfer to other fields, such as those of law, medicine or business affairs? By what methods may the greatest transfer of ability be achieved?

In thinking, reasoning, imagining and inventing we are dealing with recalled facts. *How* we deal with them will be considered in the following chapter. For the present, we will be concerned with the various types of recalled facts and with the way in which they are acquired.

Perceiving and Recalling Facts

Facts, in the first place, result from sensory perception. They are the outcome of visual, auditory, tactual and other sensory experiences with things and events. Typically ability to perceive a fact is built up by reacting consciously to many stimuli acting at once. It is based on our old friends, simultaneous stimulation, exercise, readiness and effect. For example, a child on his second birthday is presented for the first time with a puppy. At first the little dog is perceived in a variety of ways. It is a small dark thing which runs about—sometimes dangerously near—with four legs; a thing which barks, whines, scratches the door and sounds "pat, pat, pat, pat" when it runs; a thing which likes to eat and frolic. Gradually these various conscious reactions become connected with many different stimuli, so that to any one stimulus a joint response, the percept, may occur. Thus, when the child sees only a head or a tail, hears a bark, a whimper or "pat, pat, pat" on the floor, or feels a moist nose or a shaggy back against his hand, he promptly becomes aware of the puppy.

If we observe the child's behavior *in the absence* of the pet, we shall discover good evidence that he is thinking about or has an idea of the puppy. A visitor is given a detailed description of the visual appearance, the weight, bark and other characteristics of the dog. The child reports occasionally that he dreamed about his dog or that he imagined his pet doing new stunts, such as standing on its head or climbing a tree. In these cases, the child obviously has an *idea* of the animal. He is aware of the dog's characteristics when the dog is really absent.

The awareness of any thing, event or fact when it is not present to the senses we shall call an *idea.* We can think of a great variety of objects, such as dogs, cats, houses, books, men and other facts which we call objects. We can think of musical selections, spoken words, pain, accidents, a sore throat, a struggle with an umbrella, an act of courtesy—any fact, experience or event may be recalled by a proper stimulus.

REORGANIZATION AND INTEGRATION OF FACTS IN THE GROWTH OF A PERCEPT OR IDEA

The first important fact to observe is that a percept or idea—that is, a response comprising the "knowing" or "becoming aware of" facts—goes through a process of growth similar in essential characteristics to those explained and pictured graphically as characterizing the development of skills—typewriting and other abilities—in Chapter IX. It is difficult to measure the growth of the practical usefulness or richness of a fact in the objective manner that the development of typewriting ability can be practically measured by testing the number of words written per minute. For this reason we have practically no "curves of learning" for ideas. From data gathered (by Meltzer) in a study of the nature and development of "Children's Social Concepts"—such as ideas of democracy, labor, capital, etc.,—a rough graph, showing the increase in number of correct answers to a series of crucial questions, has been constructed. It appears in Figure 30. Since this curve is smoothed by combining the records of about fifty children in each grade it does not show the irregularities typical of the growth of such ideas in any one child. The curve, on the whole, is similar to some of the curves for typewriting shown in Chapter IX.

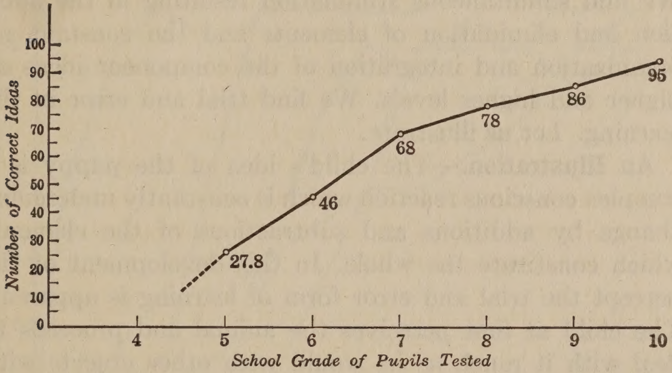


FIG. 30.—LEARNING CURVE OF AN IDEA. The curve is based upon tests of ability to answer questions about social concepts. It shows the average number of questions answered by about fifty children in each grade from grade 5 to grade 10. The individual irregularities typical of curves of learning are smoothed out since the record includes the achievements of a large number of pupils.

Curves of developing mastery of a concept which show individual variations are drawn in Figure 31. These are records for learning the appearance and significance of artificial facts which the adult subjects had to learn from near zero. They correspond to a child's first experiences in studying and learning the meanings of new facts about "things that mark on paper" or "things that float in water" or "things that live." Irregularities are apparent in these curves. It will be noted, too, that like curves of growth of skills, these courses of development are of different shapes depending on the facts to be learned.

The Principles of Learning Illustrated in Development of an Idea.—It is more illuminating to study the process of development of an idea than to observe the rough outcomes than can be shown in a graph. As we analyze psychologically the growth of a percept or idea, we again find the same features which characterized the growth of skills. We find simultaneous stimulation resulting in the addition and elimination of elements and the constant reorganization and integration of the component ideas on higher and higher levels. We find trial and error in the learning. Let us illustrate.

An Illustration.—The child's idea of the puppy is a complex conscious reaction which is constantly undergoing change by additions and subtractions of the elements which constitute the whole. In this development of the percept the trial and error form of learning is apparent. The child at first perceives the animal and proceeds to deal with it much as he would with other objects with which he is familiar. He observes legs somewhat like those of his toy chair, and seizing a leg by which to carry the puppy about, the child's idea is modified by the painful consequences. If the child squeezes the puppy too affectionately, as he might a stuffed animal, the yelp or possibly a snap results in the elimination of part of the old way of perceiving the pup, and the addition of new factors. The dog, in the course of time, is perceived and thought of as an object with sharp teeth, a certain weight, great strength and agility, a thing that mustn't be stepped on or immersed in water, which barks at birds, snaps when disturbed in feeding, and never talks, but is generally a playful companion. The child's idea of a dog is a changing, growing complex of particulars.

Analysis and Combination in Acquiring an Idea.—In the development of percepts and ideas, two processes are going on simultaneously. The complex object is, on the one hand, analyzed; the minute and subtle features are perceived. Little details of the dog's appearance and behavior are noticed. The shape of the pup's ears, the number of toes, the significance of slightly different whines and barks, the characteristics of its fears and angers are observed more and more specifically. Perception of, and consequently thinking about a dog becomes progressively more detailed and refined. At the same time, a process of synthesis or building up is apparent. Perception and thinking become not only more refined, but also more broad and inclusive; they reach higher and more complex integrations. The minute facts become *combined*

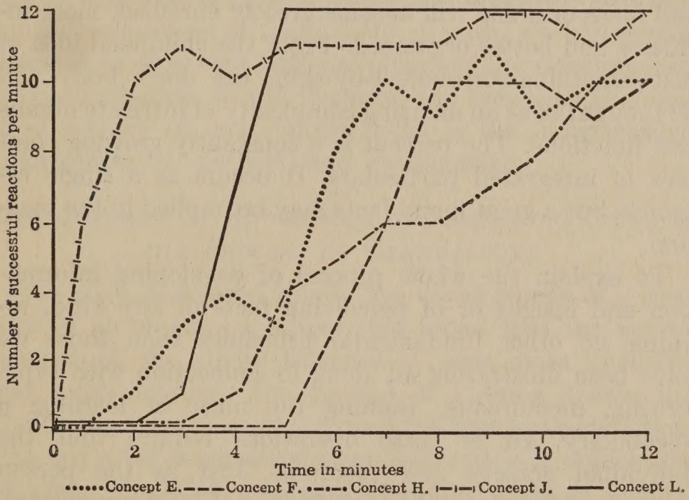


FIG. 31.—CURVES OF LEARNING FOR THE ACQUISITION OF FIVE CONCEPTS. These curves, like those for skills, show different shapes. (From C. L. Hull, *Quantitative Aspects of the Evolution of Concepts*, Psychological Review Monograph.)

into unified percepts and ideas more rich and comprehensive. Analysis and synthesis—that is addition, subtraction and integration of elementary facts—go on simultaneously and continuously so long as the child continues to disentangle new features of dog-ness, so long as he continues to observe new details. If, as a young adult, he undertakes the study of anatomy, physiology or biology, his percepts and ideas of a dog will become greatly enriched, more inclusive and better organized. From the childhood idea of just-something-surrounded-by-skin, the dog's body will be thought of as an amazing complexity of intricate organs and functions. The percept is a constantly growing complex of integrated particulars. It occurs as a single response, but a great many facts may be implied in the reaction.

To explain the whole process of developing information and insight or of perceiving facts of any kind, requires no other fundamental principles than those we have been illustrating all along in connection with typewriting, memorizing, running the maze of learning a vocabulary. All of these operations require that the individual achieve new reactions. Just as the person reacting to the typewriter must hit upon new movements, so the person studying an animal must perceive new facts in the animal's appearance or behavior. Just as the typist must react with the new movement along with the old in order to get the new element integrated with the old, so the child must respond by perceiving the new facts along with the "other, already known" facts. And just as the principle of simultaneous stimulation, as explained in Chapter VIII accounts for the new "joint" or integrated motor response, so it explains the new, unified, more inclusive idea. These facts we must emphasize for the reason that some writers in education have failed to see that motor and mental reactions can be explained by the same principle even if they are dependent in part upon different bodily mechanisms and seem to be different products.

Since some writers in education seem to feel that analysis, a reacting to minute and obscure facts is somehow incompatible with synthesis, or combination, that is, reacting with a kind of broad and inclusive, although unified, awareness of many facts at once, we had better attempt to show that both are phases of the same process. In particular we should illustrate the fact that analysis, or discovery of new, subtle facts, is the indispensable prerequisite of synthesis and development.

Development of Knowledge of Abstract Facts and the Process of Generalizing

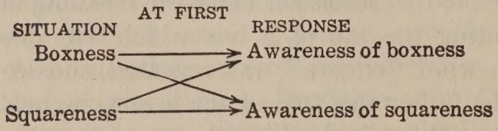
We have illustrated briefly the development of a percept of an object,—a puppy. We found that the apprehension of the object becomes at once more inclusive and more detailed. The percept of a thing always includes the awareness of its qualities and characteristics. The boy's dog is perceived as an integration or unification of many qualities and characteristics such as height, weight, color, flesh, hair, strength, sociability, etc. All of these characteristics are implicit in ordinary perception of the dog. The dime which you see on the table may be analyzed into brightness, hardness, roundness, solidity, value. To perceive the dime is really to apprehend at once a certain combination of these qualities. Not only do we perceive all of these characteristics together as a dime but we learn to perceive each of these qualities—which is usually called an *abstract* quality or *abstraction*—by itself. That which is perceived may later be recalled, *i.e.*, may become an object of thought. A tremendously important human characteristic is the capacity to think of many of these qualities in settings other than those in which they are perceived. We can come to think of the quality of roundness, area or honesty, without thinking of the concrete situation in which the qualities have been observed previously. The character has been torn out, disentangled, abstracted, during the process of perception from the other details among which it was perceived.

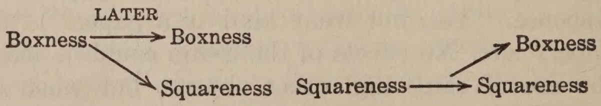
Illustrations of Abstractions.—Inasmuch as one of the important tasks of education is the development of abstract ideas, and inasmuch as such ideas are most important materials of thought, it will be advisable to ascertain as fully as possible the principles involved in such learning. In arithmetic one, two and other numbers; sum, difference, remainder, product and average; add, subtract, divide and multiply; percentage, discount, interest, profit; length, width, height, area and volume are not real objects in the ordinary sense, but elements or aspects which may appear in countless different situations. In other subjects we encounter such concepts as noun, verb, subject, predicate, object; soft, hard, big, little; triangle, circle, square; above, beside, without; north, south; if, why, how, nevertheless. Honesty, fairness, right, wrong, sympathy, liberty, justice, government, law, order,—these are facts which do not exist in the child's experience until ideas of them are laboriously acquired.

The process of development of many abstract ideas requires several years. An average child of three or four can correctly perceive a large number of objects such as a key, knife, watch, pencil, various animals, fruits and so on, but he is usually five before he understands correctly *heavy* or *light*. He is six before he has abstract notions of *right* and *left*. Not until past eight does he realize the meaning of, or take much interest in, abstract *differences*, such as the difference between a fly and a butterfly, or an egg and a stone. Not until twelve is the child able to define such abstract words as *pity*, *charity*, *revenge*, *justice*. Previous to this year, the average child may have been taught to express pity and to act charitably, but the idea has not been thoroughly abstracted. He may, too, have been taught verbal definitions of some of these terms without really having the idea in abstract form.

The Need of Many Situations Containing the Abstract Element.—To provide the proper conditions for abstracting a character, it is necessary to present a large number of different situations which contain the element. When the abstract quality is given in but one situation, or but few situations, the dissociation is seldom complete; the element remains embedded in the larger unit. A mother had attempted to teach her child the meaning of square by presenting the top of a box which was displayed while the word "square" was repeated and explained. When the father was told of the lesson, he held up a paper, asking "What is this?" "A paper," was the response. "Yes, but what kind of a paper?" "A white paper," etc. No effects of the lesson could be secured by the use of cards and other objects, but when directly asked "What is a square?" the child ran to the box, exclaiming proudly, "That is a square." The element squareness had not been abstracted. It was not known as such but only rather vaguely as a feature of the box situation. To develop an idea of squareness, one must show the child many different gross totals which contain it, such as a square card, a square desk, a square block, a square board, drawing, picture, etc. When many different situations are presented, the squareness element cannot be easily or immediately associated with them all, and it is unlikely that it will become associated with any one since it is so slightly connected with each. As the other features, let us say the "boxness," "paperness," "rugness," etc., become more numerous, each is so weakly connected with "squareness" that none is likely to be recalled—a fact more easily shown by a few diagrams.

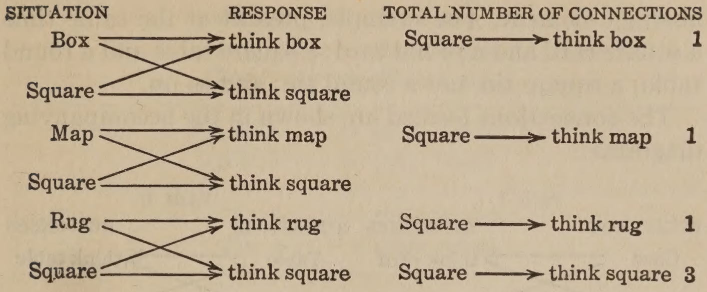
Think of each of these gross totals as including but two elements, a "squareness" element and a "thingness," *i.e.*, "box-ness" element. Actually, of course, the learner is dealing with many more than two elements. Suppose that we repeatedly present but one square object, a box, to which the responses are squareness and boxness. Then, according to the familiar principle of simultaneous stimulation, each response becomes more and more strongly attached to each other stimulus, as is shown here:


AT FIRST
SITUATION
RESPONSE
Boxness
Awareness of boxness
Squareness
Awareness of squareness


LATER
Boxness
Boxness
Squareness
Squareness
Boxness
Squareness

What we have done here is to combine the two reactions rather than isolate them. What we want, however, is not combination but dissociation.

Now, consider the next procedure, in which many square objects are presented one after another. On the left is a diagram of the connections in each of three cases; on the right a summary of these connections.


SITUATION
RESPONSE
TOTAL NUMBER OF CONNECTIONS
Box
think box
Square → think box 1
Square
think square
Map
think map
Square → think map 1
Square
think square
Rug
think rug
Square → think rug 1
Square
think square
Square → think square 3

The Connections Formed When One Hundred Objects Are Used

Square → object 1, one connection
Square → object 2, one connection
Square → object 3, one connection
Square → every other object, one connection
. . . .
Square → square, 100 connections

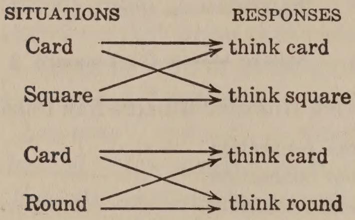
The square → square connection, however weak at the start, is gradually growing stronger without being attached consistently to any one other irrelevant response. When one hundred objects have been presented, *squareness* tends to connect slightly and about equally to each and every object, but it tends to lead to the idea of squareness more strongly since that connection has received one hundred times as much exercise as have the other connections.

In this practice, however, there is no principle actively operating toward dissociation. All that we are doing is to give the square → square connection the advantage over others by a preponderance of exercise.

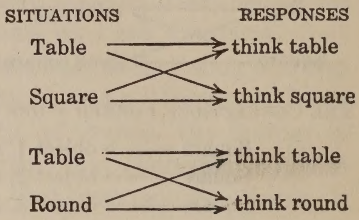
The Use of a Contrasting Abstract Element.—Another form of simultaneous stimulation provides directly for dissociation. It consists in presenting a situation which contains the abstract element *squareness* along with a similar gross situation which contains an *unlike* or *opposite* abstract element. For example, present at the same time a square card and a round card; a square table and a round table; a square tin and a round tin; and so on.

The connections formed are shown in the accompanying diagrams:

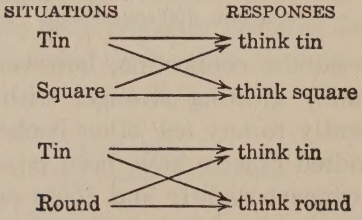
PAIR I


SITUATIONS
RESPONSES
Card
think card
Square
think square
Card
think card
Round
think round

PAIR II


SITUATIONS
RESPONSES
Table
think table
Square
think square
Table
think table
Round
think round

PAIR III


SITUATIONS
RESPONSES
Tin
think tin
Square
think square
Tin
think tin
Round
think round

If we sum up the number of times each S–R connection, for which the stimulus is square or round, illustrated above, is exercised, we get the following:

SITUATION		RESPONSE		SITUATION		SITUATION	
square	⟶	square	3	round	⟶	round	3
square	⟶	card	1	round	⟶	card	1
square	⟶	table	1	round	⟶	table	1
square	⟶	tin	1	round	⟶	tin	1

The outcome is the same as before, except that we have both round and square. But consider the following connections which appear also in this case:

SITUATION RESPONSE
Card ⟶ think square
Card ⟶ think round

Table ⟶ think square
Table ⟶ think round

Tin ⟶ think square
Tin ⟶ think round

The object tends to lead both to square and round which are, of course, mutually exclusive ideas. The result is that they tend to nullify each other, leaving the ground clear for the square → square and the round → round connections.

The square → square and the round → round connections would here be far stronger than any others, partly because they receive so much more exercise, and partly because each object is connected both with round and square, contradictory tendencies which tend to neutralize each other. The result is that in the course of time the child is able to recognize squareness and roundness in almost any situation in which it appears; and furthermore, he is able to think of square and round without recalling the particular situations in which they were encountered. He is able to think of an abstracted feature, quality or relation.

Guidance in the Acquisition of Abstract Facts.—From the analysis of the process of acquiring ideas of abstract facts, several practical suggestions for the teacher may be derived.

The Choice of Gross Situations.—Select gross totals in which the elements in question are as obtrusive as possible and encumbered by as few irrelevant details as possible. The circles or squares should be real circles and squares, not approximations. If you are trying to illustrate justice or honesty, it should not be confused with a number of other irrelevant ideas contained in the story or illustration. This is an application of an old principle which may be stated; consider the situation; see that it tends to produce the desired response.

The Avoidance of Irrelevant Details.—Care should be taken lest some other irrelevant element invariably accompany the one in question. For example, squareness should not always be presented in the form of *solid* objects, such as boxes, boards, etc.; it should sometimes be outlined on a paper or on the board, otherwise squareness may always mean a *square solid.* In teaching the meaning of noun, consider these two procedures:

A

The bird sings.
A dog runs rapidly.
Her dress is brown.

B

The horse is large.
Where is my pencil?
Please get the umbrella.

A is ineffective because the noun is always the subject of a sentence. If the child received only this form of situation, when presented with the sentence: *Who has my book? who* rather than *book* would probably be called the noun. In B, this error is avoided since the noun occurs as object as well as subject, and at the end as well as at the beginning of a sentence.

Guiding Attention to the Abstract Element.—Having selected the situations in which the element is prominent and unambiguous, the teacher may assist the pupil to react to the particular element to be learned. This may be done in various ways. In some cases the element may be pointed out, as when the teacher uses a pointer to outline the squareness of an object. It may sometimes be illustrated, or emphasized, by speech or action. Sometimes several situations containing the element may be brought to attention in such a way as to make the common factor more obvious. Thus, if the teacher were attempting to get her pupils to react specifically to the *ing* which is the ending of many common words, she might present several forms such as

The bird is singing.
The bell is ringing.
The girl is reading.

After the pupils had read these statements and selected the one which told what actually was the case in a paragraph just read to them, the teacher could call their attention to the *ing* in each of the three final words which are arranged to throw these suffixes into prominence. In general, then, the process of analysis is furthered by directing attention to the vital factor and keeping it from being dispersed or attached to irrelevant details.

Emphasizing an Element by Contrasting It with Its Opposite or an Unlike Element.—The value of this principle has already been emphasized. It is merely necessary to add that the teacher may increase the value of the contrast by emphasizing the similarities among the like, and the differences of these from the unlike, at the same time. Thus a number of round and square objects may be presented together and sorted into two groups. The common square element in one group and the round element in the other may be contrasted. Words ending in *ing* may be presented together with others ending in *ed* and the differences in appearance and significance emphasized. Pictures embracing good perspective and others illustrating poor may be mixed up, then sorted out into two groups and compared.

Inducing Pupils to React Vigorously.—You will recall that in Chapter X, we found that in learning a poem or other material, the rate of learning and the character and amount of retention were improved by introducing actual recall ("recitation") as soon as some of the material could be revived without too many errors. The same principle applies to the acquisition of abstract facts. It is very important, in fact, that the pupil be given exercise not merely in perceiving the elements as the teacher presents and emphasizes them but also in discovering them for himself. The pupil will learn to identify a subtle fact in new situations better by being guided into taking the self-active attitude of exploration and discovery than by being permitted continually to sit and be shown. Thus if the problem is to achieve ability to appreciate such facts as squareness, weight, fourness, liberty, etc., the pupil should meet many different novel situations, problems and projects which make the discovery of the fact a means to the solution of the problem or the carrying out of some purpose or project.

The method of utilizing the self-activity of the learner in the process of overcoming a difficulty, satisfying a need or purpose, solving a problem or completing a project we shall treat at greater length in the next chapter. At present we shall merely state that, just as the recitation should comprise the major portion of the activity in memorizing a poem, so should self-directed activities of finding the subtle facts in many new situations be the predominating activity in learning to generalize. By generalizing we mean precisely to discover and react to a character or common element in many new situations. To have generalized the notion of squareness or weight means precisely to be able to perceive squareness or weight in most, or all, situations which contain it. The general principle in this case may be stated as follows: *To learn to react to new situations by apprehending abstract elements, one must exercise reacting to new situations by independently perceiving those elements in them.* In other words: To learn a reaction, exercise with satisfying effect precisely that reaction. To learn to generalize, practice generalizing with satisfying effects. The provision of sensible problems and projects which appeal to the pupil as worthy of effort provides such practice and makes successful response more satisfying because it leads to the solution, satisfies a "felt need" or consummates a project.

It must be remembered, however, that just as premature attempts at recalling a poem will retard learning by making effort futile and by resulting in the practicing of errors, so premature efforts to perceive subtle facts will result in the chagrin of failure and the exercise of erroneous reactions. What the teacher should do is to utilize the forms of tuition previously mentioned which give the ability a sort of healthy birth and then provide for independent activity and discovery. Even then, the teacher should continue guidance and tuition of some sort. She should keep an eye on the pupils so as to be able to identify and assist in the elimination of errors and to observe and reward successful responses. She should also direct the course of experience so that the abstract fact is properly extended and refined. She should facilitate the process of generalization by encouraging attempts to state the essence of the idea in words. Since common practice in the use of verbal stimulations as a means of increasing insight and understanding has not always been psychologically sound, we must consider the defects and merits of such methods with some care.

The Use of Rules, Definitions and Other Verbal Explanations.—A popular method of attempting to abridge the process of acquiring ideas has been to make abundant use of theories, explanations, rules, reasons, definitions and other formulæ, presented in words, written or spoken. Verbal definitions of roundness, acute angles, or honesty; explanations of why "honesty is the best policy" or why we "carry" in addition; the use of axioms in geometry from which particular facts are to be discovered by deductive reasoning; the rules and definitions in physics and grammar—these are instances of this general practice. Older textbooks in spelling, arithmetic, grammar, history, geography and other subjects were packed with such verbal formulæ as: "*Gravity* is the accelerating tendency of bodies toward the center of the earth"; "*Justice* is the rendering of what is due or merited"; "A *fraction* is a quantity less than a unit or one expressed as the sum of a number of aliquot parts"; "A *preposition* is a part of speech that denotes the relation of an object to an action or thing"; "An *angle* is that relation of lines which is measured by the amount of rotation necessary to make one coincide with the other."

The Deductive Method.—Most of these formulæ are verbal formulations of an abstract idea. The pupil, supposedly, having learned the formula, could apply it to particular instances by logical deduction. With a minimum of practice in application, the abstract idea supposedly would be clarified and henceforth generally applicable to any particular case. This has often been called the deductive method of teaching which has been used widely in mathematics, geometry, grammar and science.

Several difficulties have been encountered in attempting to lead from the verbal formula to the particular facts. Often the definition or rule when given at the start is meaningless to the pupil. The adult understands the formula because it is a summary or general statement of the essence of the particular facts with which he is already familiar. The definition fails to be useful, and may even be worse than useless when introduced before the pupil has had enough experience to make it intelligible. The verbal definition may also be unintelligible when it is framed in words and linguistic structures that are beyond the learner's comprehension. Many of us have had the experience of suddenly realizing in our twenties, or later, the meaning of definitions, rules or poetic gems about Truth that were learned in our teens. A formula which cannot be understood because of the pupil's inexperience with the related facts, or because of linguistic difficulties, will, of course, fail to function. Even when the verbal principles are clearly and intelligibly phrased, it requires skillful teaching to make them function. There is a tendency on the part of both the teacher and the pupil to test real understanding by noting the accuracy with which the rule or definition is stated or paraphrased in words. The teacher may assume that ability to recite the axioms in geometry, or the general laws in physics or the rules in grammar or spelling is satisfactory evidence of the mastery of the facts. The pupil, seeking the line of least resistance —as most of us do in learning—finds it easier to memorize the definitions and rules than to understand them. The verbal expressions thus become ends instead of means and merely form an additional burden.

The Inductive Method.—Perceiving these objections, teachers sometimes go to the opposite extreme, utilizing what is called a purely inductive method in which the principle or the abstract fact is not presented verbally until very late, if at all. The pupil is required to abstract the rule or general truth by himself, if he can. Thus, spelling, arithmetic, grammar, moral habits and the like are taught entirely by means of specific experiences. Such a spelling rule as "*I* before *e* except after *c*, or when sounded like *a* as in neighbor or weigh," or such an arithmetical definition as "Multiplication is the process of taking one number as many times as there are units in another," or the explanation of "Honesty is the best policy," together with memorization of the sentence, is considered essentially futile.

The Combined Method.—Both practices, that of extreme dependence upon verbal formulæ and that of complete or nearly complete disregard of verbal explanations, are inadvisable. While concepts stated in words cannot replace real experiences, and while they are often clumsily framed and unwisely used, verbal generalizations and definitions may be very fruitfully employed. Their usefulness is, of course, the only real test. The reaction against rules and definitions has developed from the discovery that most of the rules in common school use were of little service. But with simplicity of linguistic construction and accuracy in describing the facts, the proper utilization of verbal formulæ will be of appreciable service.

The time at which a rule or principle should be introduced is a matter of importance. It is impossible to give a definite statement in terms of the point in the process, beginning, middle, or end, at which the definition should be introduced with best effect. *The essential requirement is that verbal generalization and specific experience should interpenetrate.* Sometimes the definition or principle should be introduced at the very start, as when previous experiences afford a partial understanding. Usually the generalization must be delayed until experience has been sufficient to make the principle partly intelligible. It should come at a time when it will to some degree illuminate the particular facts of which it is a summary or generalization and when it will be illuminated by them. Introduced too early, it is likely to be learned by rote independently of the particulars; introduced too late, its explanatory function can be only partly fulfilled. Generalization and experience must develop together, each enriching the other.

The facts may be illustrated by an experiment by Judd and Scholckaw, in which verbal explanations of the abstract theory of refraction were found to assist in clarifying the idea and in making it practically applicable. The practical test was success in learning to hit a target placed under water. One group of boys was given practice with a target under twelve inches of water, along with explanations of the theory of refraction; another was given practice without the theoretical explanation. For some time both groups did about equally well. The theory seemed to be of no value in the first series of tests—perhaps because it was introduced too early, or because it was unintelligible until it became clarified in the light of experience. But later, theory and practice did fuse with the result that the first group not only "got the idea" of refraction to some degree, but also made more rapid strides in accuracy in throwing at submerged targets, especially when the depth in the water was changed. This is the real test of generalizing, namely, the ability to see the application of a general fact or principle in a new situation. While the effect of verbal explanations alone was not tested, it is probable that by this single means, just as by experience alone, the idea of refraction would not have been developed so effectively as by the two dynamically combined.

The failure of rules, definitions, explanations and other formulæ to function may be attributed partly to the use of the wrong kind of formulation or to use at the wrong time. Definitions and explanations must keep pace with the growing idea. They must, like the idea, develop gradually. We cannot begin with a final technical definition of a fact, any more than we can begin with full-fledged knowledge of the fact. Early explanations must be incomplete if the general ideas—whether of patriotism, evolution, gravitation or multiplication—are complex and long in developing. Definitions should be enlarged to fit the experience then occurring or which has just occurred. All along the explanations must be adjusted nicely to the stage of understanding and the level of experience; the two must react upon and illuminate each other. The final and quite comprehensive formula comes near or at the end, serving to sum up the whole experience or to throw into relief its essence.

Providing Abundant Experience.—A clean-cut abstract idea is usually achieved only as the outcome of wide experience. Children may learn to act in a kindly or honest manner in a number of situations, or to add or to use the number two on many occasions, without really acquiring the abstract idea involved. The following definitions, given by children of twelve or above, illustrate inadequate notions of the real meaning of *justice*. "It means a court"; "It's the Court House"; "It means to have peace"; "to be kind"; "to be honest"; "to do right"; "to get punished." When children have such ideas as: "to multiply always means to make bigger"; "weight is what is in things to make them fall"; "adverbs are what end in -ly"; the analysis has obviously been incomplete. The idea of a number—2, 3, 4 or 5—includes many significant features which must be discovered before the notion is adequately abstracted. The number *four* means in certain instances a collection of four particular items—hats, men or tops. To know the meaning of four in this sense is to have an idea of the collective feature, and the ability to perceive the fourness of any collection of this size. Four may also mean a stopping place in a series. Thus the child may count 1, 2, 3, 4, and four-ness in this serial sense may exist apart from the collection meaning. Four, again, may mean a position; it is the number between three and five. It may also mean a relative size; thus if —— is one ———————— is four. Four may also mean half of eight; twice two; one plus three; seven minus three; the square of two; the square root of sixteen; the cube root of sixty-four; and so on. The idea of four is thus a growing concept built out of experience in which analysis must occur before combination into more meaningful units of thought may be achieved. Well arranged and rich experience is quite essential. Difficulties in thinking experienced, for example, in solving problems in arithmetic, often rest upon deficiencies in analysis of many elementary factors, upon insufficient experience in some directions, and upon total neglect of others.

The Limits of Knowledge and the Ability to Generalize.—We have just mentioned the fact that students rarely have a complete understanding of complex, abstract facts or principles. Excellent studies of Junior and Senior High School pupils' knowledge of facts or concepts in the social studies (by Meltzer, Billings, and Washburne); in the physical sciences (by Black); in literature (by Irion); in geometry (by Perry); in spelling (by Alice Watson); in biology (by Laton); in arithmetic and algebra (by Thorndike and others) have uniformly shown errors and inconsistencies in understanding and generalizing. Since we said on an earlier page that the process of learning an abstract fact or principle should result in abstracting such a concept from the particular settings in which it was identified and learned, we seem to have offered an inconsistent generalization. For that reason, we must explain the fact that insight, understanding and generalization is achieved in many degrees. We have stated moreover that every idea develops and grows by becoming simultaneously more extensive and refined on the one hand and more widely applicable to new situations on the other. A fact is never completely and infallibly mastered by anyone. Let us illustrate the situation in a way which emphasizes anew the usefulness of thinking of a fact or idea or concept not as an entity but as ability to react.

To know a fact or principle, that is to have an idea or concept, is to be able to respond to a situation by perceiving that fact or principle as involved in it. To know or understand the idea "life" is to be able to react to many concrete situations by correctly identifying them as "living" or "non-living." A study (by Piaget) shows that young children recognize "living" in many kinds of animals. A dog is alive; a cow is alive; a snail is alive. It was found, however, that in many cases the idea of "living" was tied up with the idea of self-initiated movement. It was this: A thing is alive which can move itself. The investigator then asked such questions as: "Is an automobile alive?" "Is a river alive?" "Are the clouds alive?" Errors began immediately to appear. Some children said clouds were alive because they moved; others said they were not alive because they did not really move themselves but were moved by God or the wind or some other power. That some of the children were "stumped" by the question whether plants were alive, seems to us infantile, but the most expert biologist can "stump" you and me quite as fully, by questions about certain marine forms. That is to say, they can describe things or situations to which we cannot respond invariably with accuracy. Our ideas of what "life" is remain in an incomplete stage of development. Indeed, the experts can "stump" each other. These are situations to which no one can always respond correctly by the recognition of "life."

So it is with every fact or principle. The expressions "to know a fact or principle," "to see through the situation," "to apply a principle," "to generalize," or "to abstract the essential element" are merely different ways of describing the ability to respond to a situation by recognizing correctly the particular element or character in question. Take a thousand situations ranging from the most obvious to the most subtle illustrations of *weight*. A child may be correct in ten, an average adult in a hundred, an average physicist in nine hundred, but even Galileo, Newton and Einstein would be puzzled by the hardest cases.

The main educational suggestion to which this discussion leads is that the important thing about learning and applying facts or principles is not how well a person can recite a definition but how well he can react, intellectually, to new situations by awareness that "this is a case of ————(supply addition, mass, fair play, harmony or whatever you please). An average high school student can recite the technical definition of gravity as accurately and perhaps as eloquently as Einstein—but, what a difference in practical tests of understanding the principle! The test of a fact is the ability to unearth it in, or apply it to, a new situation. Therefore, we must write another chapter on the use of facts in novel settings as a means of acquiring knowledge and ability to use knowledge. This will be the next chapter. Before beginning that chapter, it will be desirable, however, to speak of the development of certain forms of facts and certain types of understanding and insight which are closely tied up with the growth of socially approved conduct. We shall be dealing with matters usually treated under such terms as ideals or purposes or attitudes.

THE ACQUISITION OF IDEALS AND PURPOSES

Among other abstract facts, honesty, trustworthiness, justice, fair play, loyalty, mercy and the like have been included. The term *ideal* is used in several senses, but most commonly to embrace the idea of the characteristics of honest, loyal or merciful behavior plus an impulse to act in the characteristic way when the appropriate situation is provided. It is thus a form of *purpose*. Purposes, it will be recalled, were mentioned in Chapter IV as a form of motive. An ideal or purpose as a motive depends upon foresight for the reason that an individual cannot act honestly unless he is aware of what constitutes the honest course of action. The development of honesty in behavior, then, is in part dependent upon the development of the ability to perceive what we may call the honesty element in various situations. A clear idea of honesty is acquired in the same way that ideas of squareness, angles, four-ness are arrived at by reacting to many situations which contain it and its opposite, dishonesty. The learner is assisted as before by meeting the "honest" feature of many different situations, by an analytical attitude, by having the element pointed out and emphasized, by contrasting it with dishonesty, by verbal explanations and formulations and by extensive experiences with all sorts of new situations. As in the acquisition of other facts, honesty will not become thoroughly understood or dynamically effective by verbal instruction or deductive exercises alone, nor will the idea be most clearly acquired by experience alone—the two are acquired together, each supplementing the other. In moral training, each of these features must be developed—the perception of the moral quality and the doing of the moral act, followed by a satisfying state of affairs. When experience has been sufficient to enable one to perceive the moral aspect, as we perceive blueness or roundness in many situations and when the percept or idea is followed by the impulse to act accordingly, we have the ideal or purpose in dynamic form.

Children occasionally act in an inappropriate manner because they do not perceive the proper line of action; their idea is incomplete and inapplicable to some situations. For example, many seven-year-old pupils, in answer to the question: "What's the thing for you to do if a playmate hits you without meaning to do it?" give such answers as "Get even"; "Tell him to 'cut it out' "; "Tell my mama"; "Not play with him" or otherwise show a failure to perceive the essential moral feature of the situation. To extract the proper moral quality is not of itself a guarantee of proper action, but it is a desirable antecedent.

An Experimental Study.—An experimental study by Voelker gives an illustration of the simultaneous development of moral ideas and purposes and moral conduct. Six groups of about a dozen boys each, of ages ten to fourteen, were first given a series of ten tests which offered an opportunity for either trustworthy or untrustworthy behavior. Situations were provided offering the boy an opportunity to keep over-change, to steal, to cheat in an examination, to tell a secret, to make false claims, etc. Each test provided a real temptation; dishonesty would be rewarded by some immediate personal gain. The boys, of course, were unaware that the temptations were prearranged. In the first trials, the temptations were effective in various degrees, ranging from untrustworthiness in eight out of ten tests to one out of ten; only one boy was one hundred per cent honest. The average boy proved susceptible to three or four of the ten tests.

During a period of seven weeks, two groups were given intensive training, which embraced the learning of codes of trustworthiness, Boy Scout oaths, lectures and an abundance of cautions, exhortations, encouragement and explanation during games, examinations, hikes, group meetings and other Boy Scout activities. Rewards and punishments were administered as occasions made them advisable. In short, the leaders of the two groups attempted by many devices to develop and clarify the notion of trustworthiness, to develop ability to see it in many different situations and to form habits of acting in a trustworthy way by making such actions result in satisfying effects.

Two other groups were given the ordinary Boy Scout training in which, presumably, less effective interpenetration of verbal instruction and experience was obtained and the development of trustworthiness was less deliberately designed. Two other groups of schoolboys were given no Boy Scout training, and no special training in trustworthiness. At the end of the seventh week, the six groups were again put through a series of ten tests which were new in details but similar in general type to those of the first series. The two groups systematically trained in trustworthiness improved the most; the two untrained schoolboy groups the least; with the regular Boy Scout group about midway. The specially trained group did not achieve perfect trustworthiness, however. They were guilty of untrustworthy acts, on the average, in about two out of ten tests. Some of the failures probably were due to inability to perceive the right clearly, while others were instances of seeing the right but doing the wrong. The greatest improvement, however, was obtained by the deliberate selection of life situations, which afford opportunity to perceive and do the trustworthy act, along with verbal explanations and formulations such as slogans and mottoes which became meaningful by penetrating the experience and in turn made the experience more intelligible and fruitful.

But ideas become effective purposes only when they have led promptly to action that is accompanied or followed by satisfying effects. When this occurs frequently, the idea becomes an impulse to action; the individual is ready to act, and, as elsewhere, for him then to act is satisfying, for him not to act or to act differently is annoying.

QUESTIONS AND EXERCISES

1. Trace the development of your ideas of your college from the time of your arrival. Illustrate trial-and-error analysis and combination.

2. Trace your idea of the significance of the word *psychology* during this course. In what respects is the development similar to and different from that of the child as he becomes acquainted with his dog?

3. Consider the case of a child who is deaf from birth. How would you teach such a child to read and understand such words as *eyes, cold, mother, under, his, pretty, swim?*

4. How would you teach first-grade children to recognize and know the significance of the suffixes -ing, -ed, -s, and -er?

5. Criticize the teaching of concepts or principles in history, geography, physics, geometry or some other subject as it was taught to you or as you have recently observed it being taught.

6. Illustrate the statement that there are always limits to the degree to which facts are generalized or understood.

7. Illustrate and diagram an efficient method of teaching a child the idea of " warm."

8. Give samples from life of learning to respond correctly to abstractions such as "loyalty" or "honesty."

9. Give as many samples of an element with an opposite or unlike element as you can.

10. Give examples of failures of complete analysis due to (a) not varying the gross totals sufficiently; (b) having an insufficient number of gross totals; (c) failure to direct attention carefully to the element; (d) too many irrelevant details in the gross totals; (e) insufficient drill.

11. Select 10 sentences to assist in teaching the meaning of "active" and "passive" voice.

12. Make up several sentences varying the concomitants of "over" and so chosen as to direct attention to the meaning.

13. Make up sentences illustrating "justice" in which there is too much irrelevant detail.

14. How may definitions be successfully used to aid learning by analysis? What are the main requisites of a definition? Give good definitions of addition, weight, angle, subtract, hard, noun.

15. How is the Law of Effect related to the acquisition of ideals? How does an ideal differ from an idea? From mere habit?

16. Will the desired moral habits and attitudes be developed by imitation of adults? Just how will the activities of adults influence the child's learning?

17. What statements in the text would seem to favor self-government by school children? Does the text suggest that government be handed over to children suddenly or gradually?

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CHAPTER XII

REASONING, IMAGINING AND PROBLEM SOLVING

Reasoning is a form of learning. It is a term applied to types of learning that are at once very subtle and very complex. Reasoning may be contrasted with all types of mental or motor activity which consists merely in the repetition or recall of reactions previously acquired, or in mere random or aimless activity. Typically, reasoning is involved when the individual is confronted by a novel situation or a "problem-situation" for which his native and acquired modes of reaction do not at once provide a satisfactory solution. The individual's final or consummatory action is delayed and during the delay he must learn what to do. Learning what to do is, in that situation at least, a case of exploration ending in discovery: in some instances the thing learned is something never before known, or done, in such a situation by anyone. It is, therefore, an invention or creation. Despite these high-sounding terms, the process of learning what to do by reasoning is not to be sharply distinguished from ordinary forms of trial-and-error learning. The two merge, but the extremes offer important contrasts, which we shall examine.

CHARACTERISTICS OF REASONING AND IMAGINING

How Animals Solve Mechanical Problems.—Some of the characteristics of reasoning may be observed by comparing the behavior of animals with those of human beings in problem-situations which embrace comparable features. When a cat is placed in a puzzle box that may be opened by some simple manipulation of buttons or latches, its activity seems to be mainly motor. It tries to squeeze between the bars, it claws or bites at buttons, wires, strings and other objects. The activity is usually incessant; there is very little evidence that the animal thinks the problem over—at least, it does not appear to "stop and think." It continues to try all of the forms of manipulation in its equipment, until finally the right move is hit upon, apparently by accident. When the cat is again placed in the box, it gives evidences of little understanding of the solution. It apparently does not know just how the previous escape was brought about. The task of learning the way out a second time is nearly as difficult as before. The solution is gradually acquired by a process of trials, elimination of annoying errors and the selection of the successful and hence satisfying reactions.

How Some Men Solve Mechanical Problems.—The duplication of such an experiment with human subjects may be approximated by using a latch or some sort of mechanical puzzle which will be as new to the man as the puzzle-box latch was to the cat. The general features of the learning by man are often very similar to those employed by the animal. The former resorts at once to manipulation, turning the parts this way and that, twisting, pulling, pushing; sometimes repeating the same futile effort time after time—foolishly, one who knew the trick might say—sometimes shifting rapidly without apparent aim, sometimes retracing the old steps. In the course of these varied attempts the solution may be hit upon, often so unexpectedly that it is not understood at all. The second trial may then be much like the first; but at length the useless moves are eliminated while those constituting the solution are retained and perfected. This example of learning we should be inclined to call a rather stupid human performance in which little, if any, reasoning is involved. It is, nevertheless, a type of human learning that is not unusual when the problem is both novel and difficult.

Reasoning in Solving Mechanical Problems.—Some learners, however, proceed in a different fashion. They manipulate less while observing and thinking more. Holding the puzzle before them, they carefully study its construction, estimate the results of various moves, and keep on the lookout for clues or suggestions. They may also attempt to recall the solutions of other puzzles or to apply general or particular facts learned from preceding experiences with door locks and other mechanical devices. The learner does more than merely manipulate the object; he recalls various facts which careful perception of the puzzle suggests and manipulates or explores among these ideas. There is an active search to link the present problem with past experiences which utilize the same principle. This tendency to utilize recalled facts in addition to those that may be directly perceived in the problem-situation is one of the important characteristics of reasoning.

In reasoning, we have not sidetracked the familiar trial-and-error procedure. We have merely widened the field of manipulation. Not only may we explore among facts presented to the senses, but we may also explore among facts recalled. New facts may be observed not only in the situations present to the sense but in those present to mind. The recall of pertinent facts, general and particular, is an effective way of bringing our past experiences to bear upon our present difficulties. The learner succeeds in recalling *pertinent* facts; in other words, his thinking is controlled and selective. He does not recall unrelated and bizarre facts as in the dream; his purpose and aim facilitate some facts rather than others, although selectivity is rarely if ever perfect.

The good reasoner not only recalls, but he carefully observes the present situation and his own reactions. The facts observed may be later recalled so that he can rehearse the whole problem mentally, thus saving muscular work and often leading to a solution. Careful observation, too, often enables him to recall the state of affairs which attends an accidental discovery of the solution, thus avoiding the common waste of effort shown by animals that hit upon the solution without having perceived it. The careful observer may recall the circumstances and his own reaction and thus "see" how it happened or at least observe clues whose usefulness appears during the next trial. In this, as in other typical instances of reasoning, thinking is highly active, controlled and selective.

Reasoning in Solving Verbal Problems.—These characteristics may be illustrated by the solution of verbal problems of the type similar to many that we solve in everyday life. It has been found experimentally that the problem below is of the degree of difficulty that taxes the ability of, but can be solved by, an average child of nine years. Be sure to solve the problem before reading the discussion which follows it.

In cold, damp climates, root crops, like potatoes and turnips grow best;
In temperate climates, there are abundant pastures, and oats and barley flourish;
In subtropical climates, wheat, olives and vines flourish;
In tropical climates, date palms and rice flourish;

The ancient Greeks lived largely on bread, with oil for butter; they had wine to drink and raisins for fruit.

Which climate do you think they had?

To solve this problem, the child must first fix upon the main question, which requires some analysis. Out of the last two statements the "What climate did they have" statement must be combined with the notion of Greeks, so that the question becomes clearly "What climate did the Greeks have?" The solution will not be obtained unless this question is perceived and remembered. Next, information not contained in the problem-situation must be available and it must be suggested by getting the right facts together. The child must know that bread comes from wheat and not from root crops, potatoes, turnips, date palms, etc. He must know also that oil comes from olives rather than from oats, potatoes, rice, etc., and that raisins are to be associated with vines, rather than with date palms, turnips, etc. These facts—assuming that they are known—must be brought out during a process of study in which many irrelevant matters are observed and discarded. Several erroneous hypotheses may be suggested as various facts are viewed together before the correct solution is obtained by narrowing the field down to the facts contained in lines three, five and six, and seeing the relations contained therein. In reasoning the solution of a verbal problem, then, we find the analysis of the gross situation into its elements, the supplementation of these minute facts by others recalled from past experience, and the perception of previously unobserved facts in new combinations of details. This last point merits some elaboration.

The Discovery of New Facts during Reasoning.— The result of observing many details and recalling many past experiences is the possibility of reacting to many selected situations operating at once. This is our old friend the principle of simultaneous stimulation. Solutions are discovered and new ideas or hypotheses conceived by getting together in a single moment of consciousness many aspects of the present situation and of past situations more or less relevant. Sudden insights into the problem, suddenly "getting a point," seeing into or "seeing through," suddenly conceiving a solution—these are other ways in which the culmination of reasoning is described. Perhaps the best general term with which to express the outcome of reasoning is *hypothesis*, inasmuch as the "idea" conceived is not always a real solution. It is a possible solution sometimes proving to be correct, sometimes incorrect. In the latter case, the search is continued until other insights or hypotheses are achieved. The solution is an hypothesis which proves satisfactory. In difficult problems, the correct hypothesis may be preceded by many incorrect ones which are eliminated in the process of further study.

An hypothesis is really a conscious response made to several features of the problem-situation and recalled ideas acting at once. It is a case of simultaneous stimulation in which factors present to the senses and factors recalled from past experience operate at once. While "seeing" many things at once, some facts contained in them or suggested by them come to mind. Such hypotheses and discoveries during the process of thought are much like the perception of a similarity or difference among several things observed at once. Indeed, such insights are a kind of perception, except that they may occur when the facts are not present to the sense but are only thought of or when perceived and recalled facts are combined. In the latter case, they are often called concepts and the act, conception. Many discoveries are made during reasoning because so many facts apparently remote and unrelated may be brought together in thought that could not be brought together as things or events in the actual world.

Human ability to utilized facts previously experienced thus broadens greatly the opportunity to learn. This ability is, of course, the fundamental prerequisite to reasoning, to discovery, invention, creation, imagination.

Recall is essential to reasoning, but reasoning at its best is more than mere recall; it is the "seeing" of new facts in those recalled or in the facts recalled combined with those perceived. It is the apprehension of facts not previously noted. Whether this result is called a percept, hypothesis, inference, insight, concept or discovery matters little.

The suddenness with which the correct solution is achieved, though a long period of exploration may have preceded it, is frequently characteristic. It seems virtually to "pop out." Facts which amount to great discoveries are often finally "seen" with equal suddenness. To illustrate: "Haüy drops a bit of crystallized calcium spar, and looking at one of the broken prisms, cries out, 'All is found!' and immediately verifies his quick intuition in regard to the nature of crystallization." [1]

The world is full of facts awaiting some one sagacious enough to see them. The person who perceives them first makes a discovery and is quite properly accredited with genius. Others see them readily enough when they know what to look for and how to look. This point is well illustrated by a story from the life of Darwin, in which he describes his observations of some natural phenomenon after Agassiz's discovery of evidence of a glacial period in prehistoric days. "We spent many hours in Cwm Idwal, examining all the rocks with supreme care, as Sedgwick (another eminent scientist) was anxious to find fossils in them; but neither of us saw a trace of the wonderful glacial phenomena all about us; we did not notice the plainly scarred rocks, the perched boulders. . . . Yet the phenomena are so conspicuous that . . . a house burnt down by fire did not tell its story more plainly than did this valley."

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[1] Ribot, *Essay on Creative Imagination*, p. 247

The last two examples should not lead one to believe that reasoning is necessarily, or even often, a mere process of getting the facts of direct perception together or that all discoveries are things that can be seen with the eyes. Indeed, most of the really creative thinking is carried on with symbols which represent or function for abstract facts. Thus the chemist, the astronomer, the educator, the biologist, philosopher and other professional thinkers are manipulating such symbols as words, mathematical signs, diagrams and the like. These symbols are really stimuli, which bring to mind very complex and abstract facts, some of the simpler of which were mentioned in the preceding chapter. Many discoveries, inventions and creations occur during a process of getting many of these complex and subtle ideas together. Einstein's discoveries required no particular concrete apparatus or details. They came from becoming aware of new relations among a vast array of complicated facts all of which were very abstract to begin with. Thus new discoveries always represent an intellectual achievement and new inventions grow out of old ones. This is the case whether a person is employing test tubes and other concrete objects or only abstract symbols.

TYPES OF PROBLEM SOLVING

Although the problems or problem-situations encountered in life are almost innumerable, the mental operations which comprise reasoning may be much the same in all. These mental operations may be divided into the following types with respect to the general methods of procedure which are predominant:

Finding the Key to a Complex Practical Situation.—Most of the practical problems fall under this head. Typically, the individual is confronted by a complex situation, which offers a large number of possible reactions. The question is to find the one satisfactory response, that is, the solution, as when we encounter situations and ask such questions as "What is this?" or "What is this for?" "How is it used?" "What does this mean?" "Where can my umbrella be?" "How did this get here?" or "How did you do that trick?" In all of these cases the number of interpretations is legion. We must take them up one after another, try them out, reject useless clues, follow up promising lines, supplement them by recalling past experiences and trust to getting together eventually the combination of details which will suggest the answer to our question. The solution of mechanical puzzles, the search for the cause of the balking of an automobile or for the main point in a poem are of the same type. The essential characteristic of this type of reasoning is the presence of a large number of facts or details among which we find a satisfactory response.

Inductive Reasoning in Science.—In the foregoing illustrations the solution was typically some concrete line of action or the perception of some particular fact which was the key to the situation. The so-called *inductive reasoning* so abundantly utilized in science is essentially the same, except that the key is usually a general rather than a particular fact. Science aims to discover laws, or general explanations. Thus Darwin, after observing a large number of variations among animals of the same species and similarities among different species which amounted to an essential continuity, finally conceived a single explanation for all of these facts, namely, the theory of evolution. This theory was really a key to the complex situations, in much the same sense that after puzzling for a time with an arithmetic problem a child sees that the thing to do is first to add certain figures, and then subtract another figure from the sum. As a psychological process it makes little difference whether the solution is a great law or a particular fact.

Deductive Reasoning: Application and Verification.—Reasoning may take its start from a general principle and seek for particular cases which illustrate it. One may attempt to apply a general law, either for the purpose of observing whether it holds good or not or for the purpose of understanding it better by practice in using it. If the interest is in testing the validity of a general statement, the process is called *verification*. If one does not question the generalization but wishes to find new particulars which it covers, the term *application* is frequently used. In either case the general fact becomes one element in the situation which must be grasped and held in mind while various concrete situations, perceived or thought of, are viewed with it. Getting the general and particular facts together, it is necessary to perceive their essential similarities or differences; to see whether they fit or are unrelated. Of course, there must be a great deal of exploration, trial-and-error activity, in recalling particular cases and trying them out. This form of thinking, of which there are several varieties, is called *deductive reasoning* in contrast to the *inductive method*, but both are essentially the same psychologically. Both imply a novel and complex situation, a search for clues, the recall of facts and experiences and the responses to several things at once which we call an hypothesis.

Inductive and Deductive Reasoning Combined.—In many instances, both the inductive and deductive procedures are employed. In trying to figure out the use of a new piece of apparatus, a person may be led from the study of particular parts to an hypothesis concerning the whole and then attempt to verify the hypothesis by applying it to the concrete situations which the theory suggests. In scientific investigations a general law, such as the Law of Effect, which is arrived at after long study of particular events, is later tested by trying it out in new situations in which it should hold and it is finally applied broadly to meet practical needs. On a smaller scale, laboratory experiments may include the same steps: discovery of the "key" or general law, then its verification and application.

Criticism and Discrimination.—In criticism and discrimination, which in some form are perhaps the most customary types of human reasoning, both the inductive and deductive features are apparent. In buying a hat, the purchaser usually becomes critical. She begins by analysis of the features of the hat, its predominant color, the color combination, the trimming, the quality of the materials, the size, shape and style. Not only may these features be viewed singly, but they must be viewed together to ascertain the general effects. Not only will there be search to perceive the character of the details and the general effect, but there will be considerations of these in the light of certain general ideas; there will be an application of principles. For example, she must be in style; therefore, she recalls the prevailing fashion and proceeds to observe the hat in the light of it. Is this hat a particular case of the accepted style? This question is really identical with that of the man of science when he inquired: "Is this a particular event covered by the Law of Effect?" The same is true of the buyer's appraisal of the hat from the point of view of its appropriate price, or its fitness for her purpose, such as afternoon wear; or its harmony with the rest of her costume or her figure or complexion. Criticism of and discrimination among hats is, psychologically, no different from the work of the literary or musical critic, or from the evaluations in the moral, mechanical, legal, æsthetic or any other field of conscious activity. Criticism then is like other types of reasoning that have been or might be mentioned in the fact that it involves a problem-situation, the analysis of the whole into its details, the recall of related facts, general or particular, and the reaction to many things at once. Let us now take up creative imagination to ascertain in what respects, if any, it differs from reasoning.

Creative Imagination.—The reasoning involved in criticism affords about the sharpest contrast, in certain respects, with creative imagination that may be found. Compare the music critic and composer. The music critic must be able to reason; to analyze a composition, to classify and evaluate its elements in accordance with recognized norms of good usage, to see the similarities to, and differences from, other compositions, good and poor. Superficially, this type of thinking seems to be very different from that involved in creating a composition. The composer must imagine new things, not merely react to what is before him. To be sure, he utilizes recalled facts and must work, in his imagination, with musical notes. His work, however, is that of imagining new combinations of these notes; he must create. Perhaps many melodies come to him only to be discarded. They are discarded, however, in the light of some standard; because they fail to suit his purpose which may be to secure a new combination of a prescribed type. Really, the new combinations which occur to him are psychologically much like the "trials" of the person trying to solve a difficult mechanical puzzle or the insights of the mathematician working on a difficult problem, or the hypotheses of a scientist searching for a general explanation of the movements of clouds or stars. The trial movements or insights or hypotheses are really new combinations of simpler movements, operations or ideas, respectively, just as the tentative melody is a new combination of strains or notes. In all of these cases, moreover, the trial product must be evaluated in the light of other facts, rules, laws or standards of some sort. The test of the manipulative response is simply whether it unlocks the puzzle; the test of the mathematician's insight is whether it produces the right answer; the test of the scientist's hypothesis is less precise and final, but it must explain all of the facts, must explain them in the simplest way and must be consistent with explanations in related fields. The test of the musical composition is still less rigid and conclusive, but it must observe certain accepted standards of harmony, rhythm and originality. In this respect it is much like the choice of a hat; the one chosen must obey certain general requirements, but many different hats might do so quite satisfactorily. Thus the distinctions between types of reasoning and creative imagination are not so clear as they may appear at first sight. They are practical rather than psychological. The field of purposive, controlled, selective thinking is as broad as the world of facts that may be perceived or imagined but the characteristics of purposive thinking are very much alike whatever the purpose, the kind of facts utilized, the character of the products or the nature of the tests of validity applied.

Rationalization or Self-Justification.—Along with criticism of others, justification of oneself stands high as a popular form of reasoning. Self-justification or rationalization was treated at some length in Chapter VII where our interest was more in the *motive* at work than in the process. Yet, enough was presented there to show that reasoning, when conducted to justify the things which we wish to do, or which we have done, said or thought, is the same process as elsewhere.

THE IMPROVEMENT OF METHODS OF REASONING AND IMAGINING

With the main characteristics of reasoning and imagining now before us, we may undertake a discussion of the methods by which they may be improved.

The Need of Facts.—Successful reasoning and imagining depend upon an abundance of ideas, particular and general facts and principles. In reasoning, we pick and choose among facts; view this and that together. Few people are able to reason about the Theory of Relativity, Evolution or Electrotherapy because of a lack of the essential stock of facts. And some who could reason well concerning the explanation, application or verification of these theories, might reason very poorly about a balking automobile, investment securities or pains in the chest, because of lack of information concerning mechanics, finance or the diagnosis of disease. Unless the person has had previous experience with a situation in some degree similar, unless he has dealt with material of the same sort before, he may be quite incapable of finding a solution except by accident. An eminent thinker once compared the situation during reasoning to two chambers, a main chamber in which manipulation and study were going on, or in which the leading ideas were being rehearsed, and an antechamber crowded with ideas seeking an entrance to the main room. Unless the antechamber were well filled, little could be done. The most hopeful sign of probable success was an anteroom teeming with candidates for a "trial." If we are to become competent thinkers in any line, the first, and by all odds the most important, thing is to accumulate experience and master the facts in that field. Without the facts and experience, the most gifted mind would be helpless. The most productive thinkers are not those who disregard the knowledge, methods, trials and errors of others, but those who are most familiar with them. Originality is not opposed to the amassing of facts or the laws of ordinary learning, but dependent upon them.

Facts, as we tried to show in the preceding chapters, may be acquired, in useful or clumsy form, so that other things being equal, the person who learns in the best way will be more successful in reasoning. To learn how to learn, and to learn a great deal, are the two important aids to efficient reasoning.

Originality in Art.—In thinking in the fields of literary, musical and other artistic productions, familiarity with the products and techniques of the masters seems to be quite as useful as acquaintance with the facts is essential to originality in other fields. In the æsthetic fields the fear that familiarity with other products may cramp or inhibit originality seems to be more frequently and tenaciously held than in business, mechanics or science, but for no good reason. In the better types of instruction in composition, drawing, design and the like, more attention is given than formerly to study of good products, to theory and technique. Originality is fed by such equipment; starved by poverty of examples and precedents.

The Need of Practice under Guidance.—Given an abundance of information, the task of improving reasoning or imagination is much like the task of improving other abilities such as reading, spelling, writing, or the use of oral English. First of all, there must be an abundance of practice. We learn to think by thinking. We learn to originate by creating. But just as in typewriting a learner left to himself is likely to improve slowly, to develop many ineffective devices, and to fail to acquire many elements of effective technique, so in reasoning, best results are obtained by practice under guidance. The teacher may assist appreciably by suggesting good practices and detecting several rather common forms of ineffective technique.

Keeping the Problem in Mind.—The first step in the process of solving a problem is to understand thoroughly and remember the main question.

In a test which has been widely applied to children of various ages, two small boxes weighing three and fifteen grams respectively are presented, with these instructions: "You see these blocks. They look just alike, but one of them is heavy and one is light. Try them and tell me which one is heavier (or heaviest)." In some cases, five-year-old children fail in this test when they understand the directions and are able to discriminate easily between the weights, because they forget what the problem is. The task furnished by the instructions "Try and see which is heavier," must be held firmly enough in mind to control the steps necessary for making the comparison. Such distracting impulses as to feel the blocks, pile one on the other, roll them about, etc., must be inhibited. One must move straight toward the goal. Terman, who has studied this test, finds that sometimes a very dull child starts off in a most promising way, but soon appears to have forgotten the task. "His mental processes are not consecutive, stable, or controlled. He is blown about at the mercy of every gust of momentary interest."

The problem held clearly in mind acts as a selective agency during the activities of reasoning. It tends to favor the perception of the facts appropriate to the solution of the problem. If some one speaks a sentence of which we hear only the final word *scale*, there are several ideas which may occur: a fish scale, weighing scale, music scale, scale of prices, a writing scale, "scale" a fence. But when the context of the sentence is known, the relevant meaning, and it alone, comes to mind. The successful thinker finds that out of the variety of possible meanings which each detail may yield, only the right one pops out. Others find that the right suggestion will not come. Tell a subtle joke to any group; some will see the point at once, but to others it comes slowly or not at all. When the right idea does not come, one is not left altogether helpless. One should not passively wait for something to come. Success may be achieved by instigating certain maneuvers.

A Systematic Analysis of Details.—The first maneuver is to proceed with the main question in mind and to examine actively the problem in piecemeal. Focus attention on one detail. Significant matters overlooked when the problem is thought of as a whole may be detected during an active study of one phase after another. In teaching, the habit of analytic scrutiny may be encouraged by questions directed to parts of the problem. Systematic procedure, in which details are taken up in orderly fashion, their relation to the problem ascertained and futile leads noted, should be cultivated by means of practice under guidance.

One trait, antagonistic to successful reasoning, is inflexibility. In attempting to solve a mechanical puzzle, a subject observed by Ruger spent ten hours on one line of attack. After having stated his assumption, which was an erroneous one, the subject was requested to strike out along other lines. After an hour and a quarter, he was asked again to tell what he was doing. He was still working on the same futile clue! This kind of stubbornness or inflexibility is a fatal obstruction in the pathway of reason, and is reminiscent of the logic-tight compartments mentioned in Chapter VII. It amounts to sticking in a rut, closing the mind to new suggestions and results in disregarding very obvious clues. In dealing with many practical situations as well as political, social and business issues, the same tendency appears as a disinclination to change a point of view, or even to reconsider an old problem. To attempt to change an opinion, to venture a new solution of a problem, is usually somewhat disturbing and perplexing in much the same way as an attempt to speed up in reading or adding or to adopt a new method of typewriting. The ease and security which results from standing by old habits of thought and action oppose the tendencies to break away, to develop and try out new possibilities. Extreme conservatism, stubbornness and inflexibility, then, are habits that the good thinker must avoid. Originality depends, in some degree, upon habits of openmindedness, of keeping alive to wide variety of stimuli, and of remaining sensitive to all of the suggestions that a situation may contain, rather than in thinking only along the line most readily suggested.

Some subjects show a tendency to skip about among the details of a problem in a superficial fashion, which is quite as serious a fault as too great a tenacity in sticking to a few clues. A promising line is undertaken and followed up for a while, only to be suddenly dropped as another suggestion occurs. This kind of learner is too readily distracted; he is continually getting very ''warm,'' but by hastiness is robbed of a victory fairly within his grasp. In solving problems in arithmetic, history and civics, and in practical affairs, habits of careless superficial thought may betray themselves in impulsiveness. The child leaps to conclusions with little effort to test the results. This is, indeed, a quite common form of human fallibility. There seems to be a native disposition to accept as reliable any idea that comes easily. While guessing is to be encouraged and while it is in general healthy to entertain suggestions that thinking produces, it is quite as desirable to establish habits of maintaining a state of doubt, of being critical and of testing suggestions before they are accepted.

Formulating Hypotheses.—Both "scatterbrain" thinking and inflexibility may to some extent be remedied by cultivating the habit of systematic procedure coupled with efforts to formulate articulate hypotheses, or possible forms of solution. After a preliminary survey, the subject should fix upon what appears to be the most pertinent facts and, considering them in connection with the problem, formulate a clear-cut guess or hypothesis concerning the solution. Teachers may assist by asking the pupil, "What is your problem?" "What facts are you now considering?" "What do you think is a possible solution?" The learner should work, not aimlessly waiting for things to happen, but with a definite question or assumption in mind. Each assumption should be tested until its worth is determined beyond a reasonable doubt, then dropped and another taken up, until one by one the possibilities are exhausted. Such a procedure tends, for one thing, to narrow the field of operations. If the solution does not show itself spontaneously, it may be finally cornered and thus captured. Changes in the assumptions widen the possibilities for suggestions, since the same details may be perceived differently as words may have different meanings, when the point of view is changed. Solutions coming as the answer to the question, or in the course of the testing of a hypothesis, are better understood than those which "just come." If the solution is anticipated, and linked with an assumption, it is better observed and understood. Usually an assumption grows out of past experience which is formulated as a general rule or principle. The present solution is then perceived as a case which fits into a familiar type.

Generalization.—The subject, then, should study details in connection with the main problem, attempt to guess the solution as he goes along, give each guess a fair tryout and advance systematically. When the problem is solved, it is advisable frequently to review some of the steps in an effort to generalize, or get the principle of the problem. The value of generalization was shown very clearly in the studies of mechanical puzzles, as indicated in the following quotation from Ruger: "A certain puzzle was so arranged that it could be presented in various forms. The manipulation for these various forms could all be comprised under a single formula. This general formula could be deduced from any one of these special forms. A number of subjects were tried with the puzzle. As soon as skill was acquired in dealing with one form of the puzzle it was changed to another form. The subjects who developed the general formula during the solution of the first form were able to use in the second form the specialized habits built up in the first form. Those who formed merely the special habits without developing the principle, attempted to carry over the habits without modification and were greatly embarrassed by the change."

The value of the generalization is quite as great in the individual acts of problem solution as in the wider investigations of science. The development of general principles is, as we observed in Chapter I, the outstanding aim of science. The usefulness of general principles lies in the effectiveness with which they may be applied and thus explain individual problems. The subject who extracted from the complexity of the mechanical puzzle the general rule, succeeded in applying it to other situations, thus achieving the solution at once. The good thinker not only solves his problem but explains the solution. He seeks an understanding of this particular experience in the light of others, especially in the light of some general rule or formula, as illustrated in an incident recorded by James:

> "I am sitting in a railroad-car, waiting for the train to start. It is winter, and the stove fills the car with pungent smoke. The brakeman enters, and my neighbor asks him to 'stop that stove smoking.' He replies that it will stop entirely as soon as the car begins to move. 'Why so?' asks the passenger. 'It always does,' replies the brakeman. It is evident that the connection between the car moving and smoke stopping was a purely empirical one in the brakeman's mind bred of habit. But if the passenger had been an acute reasoner, he, with no experience of what that stove always did, might have anticipated the brakeman's reply, and spared his own question. Had he singled out of all the numerous points involved in a stove's not smoking the one special point of smoke pouring freely out of the stove-pipe's mouth, he would, probably, owing to the few associations of that idea, have been immediately reminded of the law that a fluid passes more rapidly out of a pipe's mouth if another fluid be at the same time streaming over that mouth; and then the rapid draught of air over the stove-pipe's mouth, which is one of the points involved in the car's motion, would immediately have occurred to him."

Verification of Results.—In the scientific method, generalization is closely related to verification. The general hypothesis is not accepted uncritically but put to the most rigid test. It is verified by retracing all of the steps by which it was achieved, by application to new situations which seem logically to be covered by it, and by searching for instances which are contradictory. Whether application and criticism is wholly mental or carried out in the form of miniature tests and experiments, the outcome to be sought is a habit of self-criticism, or reasonable doubt, of impersonal verification.

Habits of testing an obtained solution are of threefold value. They assist pupils to analyze their own difficulties, to detect their own errors and to understand the conditions under which thought goes astray. They assist the pupil to maintain a standard of accuracy for himself. They lead to a more impersonal attitude toward thinking, to a tendency to adopt the scientific attitude of distinguishing evidence from prejudice and logic from fancy.

The Study of Scientific Methods.—The methods of science, as we observed briefly in Chapter I, are little more than an outline of an ideal form of reasoning. Indeed, the methods of science were devised precisely because individual thinkers are often prejudiced, untrustworthy and superficial. As the man of science must surround himself at every step with cautions and checks in order to arrive at the correct conclusion, so the thinker in ordinary matters should exercise similar precautions. "Scientific thinking" is merely careful, critical, safeguarded, systematic thinking. Detailed descriptions of the procedures by which men of science have solved their problems and achieved discoveries, as well as the rules by which their thinking is governed, constitute models worthy of emulation.

The Study of Logic.—Logic is the study of the outlines of representative forms of reasoning. Logic is not much concerned with the processes of reasoning, that is, the difficulties of keeping the problem in mind, the futile moves, etc. It is concerned with the validity of the results reached—whether the solution is justified or not. Logic is related to reasoning in somewhat the same way that grammar is related to composition. The study of grammar will do little to develop skill or style in writing, but it will assist in the task of detecting correct and incorrect usages and enable the learner to repeat the former and avoid the latter. Similarly, logic may assist in indicating forms of thought that are valid and invalid.

In logic, samples of reasoning are analyzed into their elements, which are usually displayed in a simple graph, diagram or short series of sentences. These summaries make more apparent various fallacies that were obscure when expressed in cumbersome or expansive verbal form. The various correct and incorrect forms of reasoning may also be classified in several types. Once an effective classification is made, reference and interpretation may be facilitated.

Properly utilized, knowledge of logic—especially of the common fallacies in thought—may be of some value in developing more valid and rigorous habits. But like rules in grammar or spelling, rules of logic may be learned quite independently of the activities they are supposed to assist. One may fail to understand the rules adequately, or may forget them, or fail to utilize them, or be unable to utilize them. Like other verbal formulations, to be useful they must be introduced during concrete experiences. They must be illustrated by and fused with the activities of reasoning.

The Study of Methods Used by Great Thinkers.—Men and women of eminence in fields of reasoning, creative imagination and invention sometimes undertake to describe the general methods used or the detailed steps found in some phase of their work. Such accounts differ widely both in validity and suggestiveness. In the main, great thinkers, composers, artists, inventors really do not know how their results are achieved in anything approaching detail. As in reading or singing, playing the violin, perceiving distance or traits of character, it is one thing to be a good performer and quite another to know how the ability was acquired or how the performance now goes on. One rarely knows. The usual accounts, therefore, are more likely to be rationalizations than genuine observations, comparable with the familiar magazine accounts of "How I Lived to Be a Hundred Years Old." They are likely to be full of erroneous ideas and lacking at the really vital points. Indeed, the happenings at the vital moments of reasoning or imaginative thinking are so complex and subtle that they scarcely permit analysis.

Supervised Problem Solving as a Group Activity.—The returns for time spent in introducing the facts of logic, scientific methods, illustrations of how eminent people solve their problems and other verbal instructions concerning reasoning will at the best be quantitatively small. The slender improvement thus secured will, however, be eminently worth while. Greater advances will result from careful supervision, in which individual defects and deficiencies are discovered and sagaciously remedied, and in which good habits are recognized and rewarded.

To utilize recitation periods not for the purpose of conducting inquisitions but to stimulate, exercise and improve habits of thinking is one of the most productive of modern methods. The social group provides not only a situation which brings out certain idiosyncrasies such as timidity, extreme caution, hastiness, pugnacity, stubbornness and tendencies to rationalization or self-justification, but it provides the most effective weapon—group opinion bluntly or subtly expressed—with which to remedy the difficulties found. It is in group activity that both the "problem attitude"—that is, the tendency to question reasonably, criticize, evaluate, explain rather than merely accept—and the "scientific attitude"—that is, the tendency to think cautiously, thoroughly, systematically and impersonally rather than carelessly or with prejudice—may be most adequately developed.

Difficulty versus Success.—The difficulty of problems should be carefully adjusted to the capacity of the pupil. Problems on the one hand may be too easy to enlist the child's best and livest interests and abilities; on the other hand, they may be too difficult, inviting the chagrin of failure. There is little interest in the attempt to lift a 500-pound weight which means failure, or in continuously twiddling one's thumbs, which is monotonously easy. Activities that exercise one's maximum abilities, physical or mental, are most useful and interesting.

Of the two defects in the choice of reasoning problems, the most common is the selection of materials and situations that are too difficult. Inventories of achievement in problems in arithmetic, geography, civics and other school subjects show too large a percentage of failures. In part, this fact has been due to the belief that mere difficulty—hard issues, or challenges—are the most effective incentives to reason. It has been believed that the "problem attitude" is stimulated by great difficulties, that children enjoy meeting the challenge which a hard task presents. What children really like is not insurmountable difficulty but the mastery of a real problem. They are not so much interested in merely facing a difficulty as in successfully overcoming a difficulty. Successful achievement, getting things done, feeling one's power—not annoying lacks and perplexing failures—these are the incentives to further accomplishment.

> "As between difficulty and success, success is in the long run more productive of thinking. Necessity is not the mother of invention. Knowledge of previous inventions is the mother;

original ability is the father. The solutions of previous problems are more potent in producing both new problems and their solutions than is the mere awareness of problems and desire to have them solved." . . . "Not getting answers seems as a rule to make us stop trying to get them. The annoying lack of success with a theoretical problem most often makes us desert it for problems to whose solution the existing bonds promise to be more adequate." [1]

Adjustment to Age and Individual Differences.—Series of reasoning problems, graded according to difficulty, may be usefully employed to ascertain the level which the reasoning abilities of children have attained at various ages. Such problems may be utilized as a scale with which classroom materials may be compared. They may also be employed to evaluate individual abilities, to discover inappropriate methods of reasoning and to encourage better technique.

A Series of Graded Reasoning Tests.—Each of the following is selected from a set of five for each age. The problems are of such difficulty that approximately one-half of the children of a given age will succeed and one-half will fail.

7 YEARS

All wall-flowers have four petals: this flower has three petals. Is this a wall-flower?

8 YEARS

All great men work hard and long every day: Sir John Smith worked three hours a day. Was Sir John Smith a great man?

9 YEARS

Three boys are sitting in a row: Harry is to the left of Willie: George is to the left of Harry. Which boy is in the middle?

10 YEARS

There are four roads here. I have come from the south and want to go to Melton. The road to the right leads somewhere else: straight ahead it leads only to a farm. In which direction is Melton—north, south, east or west?

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[1] E. L. Thorndike, *The Psychology of Arithmetic*, pp. 278 f.

11 Years

Where the climate is hot, aloes and rubber will grow: heather and grass will only grow where it is cold. Heather and rubber require plenty of moisture: grass and aloes will grow only in fairly dry regions. Near the river Amazon it is very hot and very damp. Which of the above grows there?

12 Years

Field mice devour the honey stored by the bumble-bees: the honey which they store is the chief food of the bumble-bees. Near towns these are far more cats than in the open country. Cats kill all kinds of mice. Where, then, do you think there are most bumble-bees—near towns, or in the open country?

13 Years

A pound of meat should roast for half an hour: two pounds of meat should roast for three-quarters of an hour; three pounds of meat should roast for one hour: eight pounds of meat should roast for two hours and a quarter: nine pounds of meat should roast for two hours and a half. From this can you discover a simple rule by which you can tell from the weight of a joint how long it should roast?

14 Years

John said: "I heard my bedroom clock strike yesterday, ten minutes before the first gun was fired. I did not count the strokes but I am sure it struck more than once, and I think it struck an odd number." John was out all the morning, and his clock stopped at five to five the same afternoon. When do you think the first gun was fired?

Need for a Systematic Program Aiming at Self-Management.—Although such series of graded tests as the one just given may be put to several uses, the arrangement in age groups should not be considered as indicating final limit of attainment for average pupils. Indeed, why are we talking about methods of improving the technique of thinking and problem solving if it is an impossible achievement? In each subject and activity, education should aim toward more impersonal, more comprehensive and more accurate thinking. Such growth can be achieved only by utilizing a well-conceived program in which the most significant problems in the subject, within the interests and abilities of the pupils, are handled in such a way as to extend continually the techniques of reasoning. Such a procedure would realize a gradual evolution of ability. The work of a year would represent continued change not only in subject matter, but also in techniques and in independence and originality.

In one study of teaching history (by Helseth) in which such a program was skillfully employed, the possibility of growth in grades 7 and 8 during a single year is indicated by such comparisons of the work in September and the following May as the following: "In September the pupils sat passive, reciting when called on the words in certain parts of prescribed books. In May the pupils themselves introduced the problems—and used a wide range of extra books, magazines, etc.—to satisfy their own sense of what the problem implied. The teacher's share in the spoken words of the classroom had been reduced from 60 per cent to 14. Growth came also in 'ability to frame questions to organize a range of facts—to organize work in which questions and solutions continuously supported and advanced one another—to plan and criticize their own methods of work.' Evidence of the last form of growth was found in the fact that at the beginning of the year the class, as a group, was able to give only twenty-five scattered suggestions concerning methods of studying and reasoning in history, whereas at the end they drew upon an orderly list of two hundred and ten. Tests of attainments whether demanding mere facts or the solution of genuine problems showed a marked growth. A verdict rendered by judges who followed the experiment was that:

'From meekly obedient followers of the teacher's instruction, the class had become a socially conscious group, freely and yet critically giving and taking from one another in a coöperative solving of problems.' "[1]

QUESTIONS AND EXERCISES

1. Solve the problems given at the end of the chapter and in the case of those which offer the most difficulty, attempt to describe the mental operations involved.

2. Typewrite the problems and try them on children of different ages. See if you can ascertain the good and bad features of their method of reasoning.

3. Do you think such a list of problems really provides a measure for general ability to reason? For which of the following fields of reasoning would it probably be the best test—law, medicine, mechanics, business, music, science, history, art, philosophy, economics? For which the poorest?

4. If you were to extend this list to make a better test of ability to reason, what kinds of *content* would you prefer?

5. Do you think that training in logic or scientific methods would increase efficiency in solving such problems? Would training in arithmetic? Grammar? Geometry? Algebra?

6. Buy a few mechanical puzzles from some toy store. Carefully examine your procedure during solution. See if you can apply any of the suggestions given in the chapter. Try the same puzzles on friends, both children and adults. Record the time required to solve the puzzle. Put the puzzle together and have them try it again and repeat until they reach a physiological limit. Compare the methods of children and adults with references to care in observation, the search for general principles, the recall of previous experiences, the formation and use of hypothesis, the understanding of the solution, etc.

7. See what you can do by way of explanation and illustration to improve the methods of attack used by others.

8. Invention. The ordinary tooth-paste tube is unattractive, unhygienic and clumsy. Think of some attractive mechanism—if possible, a more permanent bathroom fixture—that will remedy these defects. While doing so compare the mental operations with those observed in solving the verbal or mechanical puzzles. What are the

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[1] From I. O. Helseth, *Children's Thinking*, Teachers College Bureau of Publications, 1926.

similarities and differences? Is this type of invention reasoning or creative imagination? Justify your answer.

9. Artistic creation. The ordinary collar and tie which men persist in wearing is not comfortable, not especially attractive, and troublesome to use. Imagine and, if possible, sketch a new neckgear that is more attractive and comfortable and also practicable. Compare the mental operations with those above. Is this a sample of reasoning, imagination or what? Compare it as a type of thinking with the creation of a new dress or wall-paper design or a new melody.

10. Try to locate in an autobiography or magazine article or elsewhere, some eminent thinker's account of how he solved some particular problem or made some invention. Examine the report critically, especially those in which advice is given, to observe what really useful suggestions are presented.

11. What facts presented in previous chapters bear upon the study of reasoning?

12. Does the average farmer, chauffeur, stenographer, salesman, cobbler, housewife, physician or banker reason very much? After several years of experience in any of these vocations, is it more or less *necessary* to reason in order to get along efficiently than at the beginning? After several years is one more or less *able* to reason in that field?

13. How often do you reason when it is not necessary or "for the fun of it"? Just what *is* the "fun" of it? Has it an instinctive basis?

14. Criticize or defend these statements: "Necessity is not the mother of invention. Knowledge of previous inventions is the mother; original ability is the father."

15. State your opinion on these assertions: (a) We require in general too much learning by rote in our schools and colleges; (b) If we clutter the student's mind with memorized facts we interfere with his thinking; (c) It is not that too much is memorized, but rather too little; (d) It is not that too much is memorized, but that unessential material is learned; (e) Not too much memorizing, but memorizing in ineffective ways.

16. Of the various suggestions offered for the improvement of reasoning, which do you consider most important? Which least important? Why?

17. Which is more likely to stimulate a high-school boy to think,—the study of formal logic or a serial detective story? Will either improve ability to reason in general? What material would be better than either?

18. If you were trying to encourage students to attempt to think, to invent, create, solve problems—would you choose tasks very easy or very hard or moderately hard. Why? Compare with your choice of opponents in wrestling, tennis, etc. Is there any basis of comparison here? If so, what?

19. While solving the following riddles, see if you can detect inappropriate methods in your procedures:

(a) Use me well and I am everybody. Scratch my back and I am nobody. What am I?

(b) What is full of holes and yet will hold water?

(c) The man who made it wanted to sell it. The man who bought it never used it. The man who used it never saw it. What is it?

20. If possible, visit a school class engaged in recitation of geography or some other subject and prepare a critical report about the teacher's method of inducing the children to reason or imagine.

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CHAPTER XIII

THE TRANSFER OF TRAINING

In the preceding chapters we have considered mainly the amount, rate and limits of improvement and the factors which contribute to making the amount great, the rate rapid and the limits high. In this chapter, we shall consider the degree to which training in one line may contribute to ability in another. Does practice in perceiving, memorizing or reasoning with one type of subject matter improve that mental process in general? Can we improve memory, perception, imagination, reasoning in all fields by practice in one? If the answer to these queries is a positive one, it would be proper to ask a still broader question: Can we improve the mind or intelligence in general by practice in memorizing non-sense syllables, perceiving small differences in colors, visualizing faces, solving problems in arithmetic or by other forms of practice? Similar questions might be asked, such as: Can we improve initiative, originality, perseverance, reasonableness, love of truth, dependability or—more broadly—character and personality by practice in a specific task? And if so, in what tasks, by what kind of practice and to what extent?

There have been many notions concerning the nature of such traits as we have listed. We shall be able to consider only two main types of theories, without giving the details of several varieties of hypotheses that might be grouped under either type.

THEORY OF MENTAL FACULTIES AND FORMAL DISCIPLINE

One theory, old in the history of philosophy and science and now widely popular in other circles, is the *theory of mental faculties*. According to this hypothesis, attention, memory, imagination, reason, will, temperament and sometimes character and other traits are powers or faculties of the mind. Usually the several faculties are held to be mainly, if now wholly, independent of each other. The mind or personality is divided into a number of faculties. Each faculty is a general power, capacity or character which possesses a definite unity. Individuals are assumed to have good, medium or bad memories, judgments, wills, characters or temperaments. A particular individual may have any combination; he may have a good memory, average reasoning ability, poor will and character but an excellent temperament. Each personality is the result of some combination of a relatively small number of faculties. It is assumed, moreover, that any particular faculty shows itself as about equally good, average or poor in all situations. Memory, to be concrete, is the power of acquiring facts. If you have a good memory everything is easily learned; if your memory is bad, all facts are learned with about equal difficulty. Will is assumed to be the power of voluntarily controlling action. If your will is strong you are the "Captain of your fate" in all situations; if your will is weak, you are about equally incapable of controlling your activities in all phases of life.

Those who hold this view assume that the faculty is a power, capacity or personal characteristic that may be trained as a whole. It is an entity and it may therefore be improved as a unit. What we need to do is to find the kind of exercise that will train the memory, imagination, will or character most economically. Once the faculty is strengthened by this device it will be, thereafter, more efficient for any purpose to which it is put. If a psychologist were devoted to this view, his procedure in diagnosing a student's difficulties, for example, would consist of a survey of the several faculties. The trouble might be in attention, memory, will, imagination, sociality, temperament or character, or in several of these. Having found the deficient faculty, prescriptions for intensive training of it, alone, would be given.

Various materials, devices and methods have always been suggested for improving each faculty. For example, less than twenty-five years ago college presidents and other educational authorities offered special school subjects as a means of improving most of the typical faculties. These quotations indicate points of view confidently held. "Study of Latin trains the reason, the powers of observation, comparison and synthesis." "The pursuit of mathematics gives command of attention" and results in "the strengthening and training of the reasoning powers." "For developing the character, strengthening the will and cultivating a wholesome temperament there is no discipline superior to athletics." "Will power and attention are educated by physical training. When developed by a special act, they are developed for all acts." There have always been individuals, moreover, who believed that courses of training utilizing materials of a special sort, different from the regular academic subjects and activities, would be even more effective as means of developing the several faculties. Though some favor various "schools of hard knocks," others provide easier methods. The easiest methods, widely advertised and sold, are the commercial systems for training memory, concentration, will power, social adeptness, originality, imagination, pose and so on.

The notion that the mental faculties could be developed uniformly as a whole by training in one subject or on one kind of data has been known in education as the *Theory of Formal Discipline.* The term *formal* implies that it is the *form* of the activity and not its content, not the subject matter itself, that is important in education. If the activity is of the form of memorizing then, it is assumed that memory could be trained no matter *what* is memorized. To learn to reason, one has merely to practice the forms of reasoning. The term discipline implies the real spirit of the theory which is that the major virtues of a tenacious memory, an inflexible will, pure and impersonal judgment and reason are to be secured only by very rigorous and full exercise of the faculties.

THEORY OF MENTAL REACTIONS

Opposed to the faculty theory is the *theory of mental reactions*. According to this view, the organism deals primarily as a whole with each of the innumerable situations, problems and classes of data that it encounters. This theory assumes that attention, memory, intelligence, will, temperament, character and the like refer not to distinct faculties, powers or entities but to some aspect or artificial classification of the process of organic adjustment to the situations which life affords. These terms refer not to entities but to abstractions; they are aspects of a whole process which cannot actually be broken up although we can *think* of each phase by itself.

According to this view, learning is reacting in a complex way to some situation or data. What one learns is to react to a particular situation or to deal with particular data. Training, then, in one situation or with one type of material will not be expected to improve character, temperament, will, memory or reasoning, in general but will result merely in improved adjustment to one situation or in increased ability to deal in some definite way with one type of data. This view assumes that a specific type of training, while it will not improve any faculty so that it will be more efficient for all purposes, may, nevertheless, result in a transfer of improvement to other situations or types of work which have much in common with the situation or type of work in which the training was conducted. That is to say, while this theory would deny that practice in tennis would improve your attention, concentration, will or temperament for meeting all situations or for dealing with all kinds of data equally, it would affirm that certain skills, habits and attitudes such as judging the flight of a ball, remembering to keep your eye on the ball, to keep cool by thinking of the game instead of the spectators, etc., would carry over to another activity such as handball, to the extent, roughly, that the two games and the general situations have common elements.

How shall we decide between these two general views? There are several forms of evidence which bear upon the problem, but by far the most crucial tests are the experimental studies of the amount and nature of the transfer of training. There are three main questions to be settled by experiment: (1) What is the amount of transfer? (2) What is it that transfers, if anything? (3) What is it that causes or prevents transfer?

Experimental Tests of the Validity of the Theory of Faculties and Formal Discipline

The studies to be reported first are concerned with the *amount* of transfer of the results of unguided training of memory, perception and similar alleged faculties. By "unguided" we mean that the subjects of the experiments were merely assigned learning tasks and permitted to work. Few or none of the various forms of guidance suggested in the preceding chapters were introduced. Such experiments test the assumption that formal training is a means of improving "mental faculties."

Transfer of Training in Memory.—William James in 1890 was the first to attack the problem of memory training experimentally. James and four of his students each ascertained the time required to memorize material from one author, such as a section of Victor Hugo's *Satyr*, and then after spending about 20 minutes per day for a month or more learning material from another author, they again memorized passages from the *Satyr*. Three of the four students showed improvement while the other student and James himself found no transfer. These experiments were really too crude to be conclusive but they are of historical significance since they stimulated further experimental studies by methods more refined.

The approved technique of studying transfer consists in dividing a group of subjects into two or more groups which are approximately equal in ability. All of the individuals are then given tests of ability to memorize each of several kinds of material. This is called the initial test. Each of the other groups, called the *trained group*, is then given training, usually daily, in memorizing one type of material. One group, called the *control group* is given no special training during this period but is given, simultaneously with the trained group, a series of final tests immediately after the completion of the special training. This device makes it possible to determine how much improvement in the final tests is due to the special training received by the trained group (or groups) since the gains, due to taking the initial and final tests alone without other training, are revealed by the control group and may be subtracted. This *Control Group Method* is an important and much-used procedure in psychology. This procedure is illustrated in following the study by Sleight:

A group of women students were divided into four subgroups. Group 1, a control group received no special training; Group 2 learned poetry 30 minutes a day for 12 days; Group 3 memorized tables, such as population data, export and import tables, and foreign coinage systems 30 minutes a day for 12 days; Group 4 spent 30 minutes a day for 12 days attempting to learn the substance of scientific, historical or narrative prose selections read to them. Just before and just after the practice series, the abilities of all four groups were measured in the following kinds of learning:

(1) Learning series of names and dates given orally.
(2) Learning series of non-sense syllables given orally.
(3) Memorizing pieces of poetry, read by the experimenter and repeated by the subjects.
(4) Memorizing prose, as in (3) verbatim.
(5) Getting the substance of a prose selection presented orally.
(6) Memorizing a series of nine letters read but once.

By comparing the improvement of each of the three *practice groups* in each function with that of the *control group*, the transfer of training was measured. The results, briefly, were as follows: Each group gained rapidly in the kind of learning specifically practiced. The influence of training in one type of learning on other types was sometimes favorable, sometimes unfavorable. Practice in memorizing poetry produced some improvement in learning tables, non-sense and prose literally, but a *loss* in ability to learn prose substance or recall letters. Those who practiced learning tables were more able to learn tables, prose substance and non-sense, but less able to learn poetry, prose verbatim and to recall letters. Practice in getting the substance of prose had a bad effect upon all other forms of memorizing save the "immediate" memory for series of nine letters. Transfer may be positive or it may be negative. Practice in one kind of learning may facilitate or it may inhibit other kinds of learning within the same general field.

Other investigations of the effects of the training of memory for one kind of material have shown a transfer of improvement to memorizing other kinds of material that is seldom great, usually between five and fifteen per cent of the amount of gain made in the kind of memory specifically practiced. Often it is less than five per cent and occasionally zero or negative.

The Transfer of Training in Perception.—One of the earliest experiments on transfer in the field of perception was performed in 1903 (by Thorndike and Woodworth). They found that subjects who had practiced estimating the areas of rectangles of certain sizes (10 to 100 square centimeters) until large improvement had been attained, showed only about a third as great improvement when slightly larger rectangles (150 to 300 square centimeters) were given or when the areas were kept constant but the shapes changed. These investigators also found that a period of training which brought about considerable improvement in judging the lengths of lines from one-half to one and one-half inches in length yielded no increase in ability to estimate lines from six to twelve inches long.

It was found that individuals who by practice had markedly increased their ability to pick out words containing the letters *e* and *s* showed less than one-third as much improvement in marking words containing *i* and *t*, *s* and *p*, *c* and *a*, *a* and *n*, or *l* and *o*. Training in perceiving English verbs gave a reduction in time of twenty-one per cent, but when the same subjects were tested in perceiving other parts of speech they showed a reduction in time of but three per cent and an *increase* in omissions of more than one hundred per cent. Another investigator (Kline) gave nine individuals practice in canceling *c's* and *t's* from thirty to forty-five minutes a day for fourteen days. Before and after the practice, the subjects were tested in canceling nouns, verbs, prepositions, pronouns and adverbs. Eight other individuals, who served as a control group, were given the same initial and final tests, but received no practice in canceling *c's* and *t's*. On the final tests the practice group showed less ability in canceling nouns, verbs, etc., than the control group. Apparently, practice in canceling *letters* may cause not an improvement but a decrease in ability to cancel *words* of certain types.

The Transfer of Training in Reasoning.—An experiment done in 1913 (by Briggs) was designed to test the hypothesis that reasoning, trained in one field, would be improved for work in other fields. The study was designed specifically to test the view, very widely accepted at one time, that rigid training in reasoning in formal grammar would increase in other fields the abilities—

(1) To test reasons.
(2) (a) To take from a mass of data all that are necessary and to use them in reaching a conclusion.
    (b) To demand all necessary data before drawing a conclusion.
(3) To reason syllogistically.
(4) To detect "catches."
(5) To see likenesses and differences.
(6) To test critically definitions of all sorts.

Fifty-four tests were devised to measure, in some form, each of these and certain similar abilities. They were given to children in each grade from two to seven in an elementary school before and after three months of intensive training of a rather formal sort in grammar and to control groups who studied composition and other subjects during the same time. This investigation showed improvement in the abilities to deal with the subject matter of grammar but not a uniform transfer of abilities to other situations. On the whole, the influence of the training on reasoning, seeing likenesses and differences, testing definiteness, seeing "catches," etc., in other fields was small at best and imperceptible in many of the new situations.

CONCLUSIONS FROM STUDIES OF THE THEORY OF MENTAL FACULTIES AND FORMAL DISCIPLINE

The Unsoundness of the Theory of Mental Faculties and the Theory of Formal Discipline.—The studies just summarized are but samples of a large number which have been performed since the beginning of the present century. It should be noted that these studies are based upon the results either of relatively unguided practice, as in memorizing in which few of the forms of guidance such as we have mentioned in preceding chapters were put into effect, or upon rather formal training, as in the teaching of grammar in which few of the devices mentioned in our chapters on generalizing and reasoning were utilized. These studies were, in fact, designed primarily to test the Faculty Theory and the Theory of Formal Discipline. The results are decidedly antagonistic to both theories for the following reasons:

(1) Although the effect of training in memorizing (or perceiving or reasoning with) one type of material is usually a marked increase in ability to memorize (or perceive or reason with) that specific material, there

appears a relatively small improvement in ability to memorize (or perceive or reason with) different, even slightly different, material. *The improvement, in other words, does not transfer uniformly and equally to the learning of other materials.*

(2) Although the effect of training in memorizing (or otherwise dealing with) one type of material is usually a marked increase in ability to memorize (or otherwise deal with) that material, its effect upon memorizing (or otherwise dealing with) some other materials may be no change or even a decrease in ability. *The transfer may be of indifferent value or detrimental as well as helpful.*

It is clear, therefore, that the facts of transfer cannot be explained as due to a general, all-round improvement of mental faculties, such as memory, perception or reason. These experiments, from the first, destroyed utterly the old theory of Formal Discipline. Teachers should no longer be misled by the notion that mental resources can be improved satisfactorily by merely seeing to it that pupils have plenty of hard, toughening exercise in memorizing, observing, judging, reasoning or what not. They should no longer entertain the false doctrine that mere training, mere hard work on one kind of material will improve any or all other "faculties."

THE FACTORS WHICH TRANSFER FROM ONE SITUATION TO OTHERS

The effects of training in one situation often do manifestly transfer to others. That which transfers sometimes increases and at other times decreases efficiency in the new situation. The nature of transfer cannot be accounted for in terms of improved faculties but it must be explained in some way. The proper explanation may appear in a study of the character of the factors which do transfer, and in surveying these factors the inadequacy of the faculty doctrine will appear more clearly.

The Transfer of or Techniques of Reacting.—During practice in memorizing, for example, a subject may learn a variety of methods of attack upon the particular subject matter, as lists of 12 non-sense syllables. He may learn to use a rhythm such as —⌣|—⌣ which is often a useful device. When he changes to the study of lists of words, the general problem, 12 items in a list to learn, may call into use the rhythmic division of the items. In this case, the use of the same rhythm probably would be useful but it might be a disadvantage in learning prose or poetry which has a different rhythm. Again, the subject may hit upon the device of learning by the whole rather than the part method, and this may be carried over. He may find that searching for peculiar syllables to serve as landmarks is profitable and this device may be used on other materials, in some cases advantageously, in others disadvantageously. From experience he may find that, in spite of his initial doubts, his memory is not so bad, and this feeling of confidence may recur whenever any task of memorizing is presented. He may actually acquire greater fondness for trying his skill in memorizing and this satisfaction may be experienced in learning new materials. On the other hand, he may acquire habits of using ineffective associations, of disliking such work, of doubting his capacity to improve and, when transferred, these habits would interfere with the learning of new data. *What is carried over, then, is not an improved faculty of memory, but a group of new devices, ideas, attitudes—in a word, a new technique, which may be good or bad in whole or in parts.*

Habits acquired in one type of memorizing, however, are by no means invariably carried over. The change from non-sense syllables in a list to digits in a row, or to isolated names and dates, or to prose and poetry may offer so few common elements that the subject starts almost anew to acquire a technique fitting the new material.

Unobserved Transfer of Methods and Movements.—Some of the reactions carried over from one function to another are not consciously identified or appreciated. In memorizing, students are often unaware of what devices they are using, much less of the circumstances under which they were originally acquired. If one practices handball for several years before taking up tennis, it will probably be found that the ability to follow the course of the ball, to estimate BOUNCE ~~bounding~~ and to make many adjustments of the body, carry over advantageously, while other transferred habits, such as hitting with a snap instead of with a swing may be disadvantageous. Some of the conditions of the new situation elicit reactions previously made to *identical* conditions in old situations. In a genuine sense they *make* the subject react as he does without awareness, necessarily, on his part, of how or why. Similarly, improvement in ability to memorize, observe or reason consists in a large measure in the development of little tricks of method usually poorly analyzed and poorly understood by the learner, but activated by the common elements of the different situations.

The Transfer of Facts or Information—In the same category with specific movements, methods of attack, emotional and other attitudes, may be included acquired reactions constituting information or subject matter. During the study of arithmetic, history or spelling, one may memorize, perceive and reason; but in addition to the training in these processes one acquires information. Facts learned in one situation may transfer like other reactions, in the sense that they may be utilized in other situations. That knowledge or subject matter is subject to transfer in the same way as movements, devices of learning and general attitudes, must be made clear, since it is frequently assumed that a fact, once learned, is of universal application. Indeed, it was just this erroneous assumption which we tried to dispel in Chapter XI. The facts are so important that we had better illustrate them again.

Suppose, for example, that a child unfamiliar with division learns the following tables as they are printed:

A

$$\begin{array}{ccc}
2 \div 1 = 2 & 2 \div 2 = 1 & 3 \div 3 = 1 \\
3 \div 1 = 3 & 4 \div 2 = 2 & 6 \div 3 = 2 \\
4 \div 1 = 4 & 6 \div 2 = 3 & 9 \div 3 = 3 \\
5 \div 1 = 5 & 8 \div 2 = 4 & 12 \div 3 = 4 \\
\cline{1-1}\cline{2-2}\cline{3-3}
50 \div 1 = 50 & 50 \div 2 = 25 & 48 \div 3 = 16
\end{array}$$

Will the facts of simple division now be available for widespread use? No, they certainly will not. Further practice must be given in mixed orders, to insure the learning of the items independently rather than as lists; for example:

B

$$\begin{array}{rr}
2 \div 2 = 1 & 10 \div 5 = \\
6 \div 3 = 2 & 2 \div 2 = \\
10 \div 5 = 2 & 8 \div 2 = \\
10 \div 2 = 5 & 6 \div 3 =
\end{array}$$

When the pupil has mastered these items, he may be unable to solve such problems as the following:

C

$$\begin{array}{rl}
10 = & \qquad 5s \\
12 = & \qquad 2s \\
6 = & \qquad 3s
\end{array}$$

While the same 10 ÷ 5 =   etc., is involved, the situation in general is so different that transfer may not occur. The child may not recognize these forms as problems in division. Specific practice having been given in the forms above, will the pupil now be able to compute such problems as these?

D

10 cents = nickels
25 cents = nickels

Assuming that they have not previously learned specifically to compute with money, many children will not make this transfer. Or consider the following:

E

5 cents pays one car fare
15 cents pays car fares
45 cents pays car fares

F

For 5 cents you can buy 1 small loaf of bread
For 25 cents you can buy small loaves of bread

G

How many 5¢ balls can you buy with 30¢?
How many 5¢ balls can you buy with 10¢?

With the tables perfectly learned, many pupils fail to solve such problems as E, F and G. The difficulty is that while the arithmetical computations are the same in the several problems, the common elements in the situation are so obscured by other details that they do not become potent except perhaps in the case of a few of the very bright pupils. Facts, in arithmetic or other subjects, cannot be acquired in any one situation in such form as to be generally applicable or transferable. A thoroughly "abstracted" notion of subtraction, or, in other words, generally applicable facility, is the outcome of acts of identifying and practicing subtraction in a wide variety of typical situations. To have a general notion of "division" means to be able to realize that this, and this, and this is a case where one should divide. To have a general appreciation of justice or a triangle is to become aware, on facing each relevant situation, that it contains the abstract element in question. In all of these situations we respond to a common, but subtle element.[1]

General Conclusions concerning What Reactions May Transfer.—We have stated that various reactions learned in one situation may be called out by (or transfer to) another situation. A motor reaction may thus transfer, even if one does not realize it. Minute and subtle techniques or methods of attack, as in memorizing, may transfer. Emotional responses, such as becoming excited or maintaining calm, feeling confident, or discouraged, when made in one situation may be called forth in another, similar situation. Such general techniques as working slowly or rapidly, or such reactions as working carelessly or slowly may transfer. The ability to use a general method such as the whole instead of piecemeal study may be developed in one function and used in another. A reaction of knowing, that is, of apprehending a fact like *above*, *weight*, *honesty*, *fourness*, *Law of Effect* or any principle or rule, having been exercised in several situations *may* be made in a new situation, which contains the essential common element. Indeed, we may generalize by saying: *Any reaction whatsoever that is made to one situation may be reactivated by, or transferred to, another situation.*

The preceding statement is really no more than a corollary of our earlier statement that what we learn is a reaction to a situation. A reaction once learned, can be elicited by the same situation and it may be aroused by others. This discussion really leads up to certain general principles already stated. We learn those reactions that we exercise; what we learn are reactions. The first question to ask about transfer is: "What reactions have been learned?" If a person during the memorizing of prose did not learn any new and improved techniques, if he did not acquire any newer or better forms of reasoning or emotional control, such reactions would bring no improvement in other tasks for the simple reason that what is not acquired cannot transfer. It was apparent however, in the experiments reported, that some techniques were acquired which increased ability in learning the particular material studied. When other types of material were offered, the improvement was not nearly so great, sometimes it was zero and sometimes there was an actual loss in ability. To explain these facts we must offer certain further considerations.

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[1] If this is not clear read Chapter XI again.

Each Situation or Material Requires Specific Adjustments.—A statement justified by the studies of transfer is that any material, if it differs at all in character from the material with which a subject was trained, requires some degree of specific adjustment before the subject can react to it as well as he did to the material on which he practiced. Thus, although there was some helpful transfer from memorizing prose to memorizing poetry, there was only a fraction of the gain in memorizing poetry that was achieved in learning prose. There was, in this case, a large number of particular "tricks of the trade" of learning poetry that were not developed in learning prose. These special techniques are examples of what we mean by "specific adjustments" to learning poetry. In learning non-sense syllables or names and dates, there are still other specific reactions required before high efficiency is possible. The same is true of reasoning. Learning how to solve the particular problems presented in the conventional study of grammar requires special techniques that are peculiar to problems of determining mood, tense, agreement of subject and predicate and the application of various linguistic rules. The solution of problems in geometry, finance, medical diagnosis or automobile mechanics may be benefited very little by the same techniques; each type of problem requires techniques peculiar to it. Thus it is quite possible for an individual capable of productive and valid reasoning in one line to be far less sagacious in other lines—even if he were well informed—unless he had, by means of specific training, acquired the particular techniques essential to good reasoning in each of the other lines. Even a reaction of apparently uniform character, like reading, is not a single combination of techniques that can be transferred without some readjustment, by means of specific learning, to all kinds of material. This appears clearly among young children who, having read only prose of 18-point type in four and a half inch lines, are more or less disturbed when at first asked to read poetry, or lines of quite different length or quite different type. Even changing from one automobile to another requires additional learning before the driver is as competent as he was in the habitual one. In general, it may be said that any change in the situation from the one to which one's reactions are adapted may interfere with the response and require some degree of learning to attain equal ability.

Conclusions.—Certain educational implications follow directly from the facts just reviewed: First, do not expect that training which has resulted in ability to deal properly with one situation, or material, or problem will enable a pupil to do *equally* well with another, even an ever-so-similar, situation. Second, take it for granted that *some* specific experience should be provided to enable pupils effectively to memorize, perceive, understand, be reasonable about, be courageous toward or otherwise adjust themselves to, a situation which differs from the ones they have been trained to meet.

THE RELATION OF TRANSFER TO THE AMOUNT OF IDENTICAL ELEMENTS IN THE SITUATIONS

The Amount of Transfer and the Amount of Common Elements.—The various studies of transfer show that, on the whole, the transfer from one situation to another is roughly proportional to the degree of resemblance among the situations. This is the same as saying that when other things, such as amount of training are equal, the more a new situation has in common with the one to which reactions have been practiced, the greater the likelihood and amount of transfer. Thus, reactions acquired in memorizing English prose are more likely to transfer abundantly and helpfully to memorizing English poetry than to learning non-sense syllables or Chinese characters. Similarly techniques in reasoning in arithmetic should transfer more surely and fully to solving problems in algebra than to reasoning about a balking automobile or the merits of a League of Nations. In general, all other factors being equal, the more elements there are in common between two situations the more any abilities or techniques acquired in one will tend to transfer to the other. This statement is a fairly good general guide if it is remembered that "other things"—some of which will be mentioned presently—are *not always equal* and that even when two situations have much in common, adjustment to one falls short of satisfactory adjustment to the other.

Now this principle that transfer is more certain to occur from one situation to another which has much in common than to another which has little in common, should be coupled with the fact presented in the preceding section, that what transfers is not an improved general faculty but merely certain reactions. It should be recalled that disadvantageous reactions transfer as well as advantageous ones. A harmful reaction acquired in situation A will transfer to a similar situation quite as fully and surely as a useful one. Hence we are required to keep in mind two familiar slogans.

(1) Consider the situation. Remember that the amount of transfer from this situation to another will vary with the degree to which the two are similar, or with the degree to which they contain identical elements.

(2) Consider the response. Remember that the reactions set up in a situation are the *only* ones which may transfer. Unless they are developed, useful reactions cannot transfer.

These two principles have a very important bearing upon the choice of subject matter and activities for the school curriculum.

Implications Concerning Choice of Activities and Subjects.—The two principles just mentioned imply that the subjects and activities of the school, and the reactions established in them, should be as nearly as possible like those actually needed in life outside of school, for the following reasons. First, the transfer of methods of attack, perception of facts, insight, techniques of learning or reasoning, interest, poise, habits and ideals of caution, honesty, accuracy, thoroughness, initiative, etc., to the situations of life will be large to the degree that the subject matter of the classroom is identical with that encountered in life outside of school. Second, the reactions which transfer from school situations to life situations outside of school will be *useful* to the extent that the pupil develops in school reactions identical with those which life outside requires. We should, then, other things being equal, have the school situation-responses as nearly the same as out-of-school situation-responses as possible. We should, other things being equal, prefer genuine life issues, and widely usable facts to unreal and fantastic problems or trivial, unusual or academic facts. We should present sensible and real problems and develop the most practicable and sensible methods of attacking them.

In arithmetic, for example, we should not tolerate such preposterous problems and such misleading methods of attack as are suggested by the following examples:

"Alice has 3/8 of a dollar, Bertha 11/16, Mary 3/25 and Nan 3/4. How much have they together?

"There are 9 nuts in a pint. How many pints in a pile of 6,789,582 nuts?

"Suppose a pie to be exactly round and 10 1/2 miles in diameter, If it were cut into 6 equal pieces, how long would the curved edge of each piece be?

"Such problems would occur in real life only in an insane asylum.

"Consider this clever way of finding the thickness of a board:

"A nail 5 inches long is driven through a board so that it projects 2,419 inches on one side and 1.706 on the other. How thick is the board?

"Consider the thoroughness of this horse in eating exactly 16 ounces of hay:

"Just after a ton of hay was weighed in market a horse ate 1 lb. of it. What was the ratio of what he ate to what was left?" [1]

Problems which represent real and worthy situations and demand the most sensible and expeditious solutions not only increase respect for and interest in arithmetic, but develop information and skill more adequately and make provision for more useful and wider transfer of all that is acquired in the way of information, skill and attitudes.

[1] From E. L. Thorndike's *Psychology of Arithmetic.*

Transfer and Curriculum Construction.—The foregoing principles provide the justification for two important movements in education which have developed within the last quarter of a century. The first is a marked and increasing activity in determining what words we need to spell, what arithmetic computations we need to use, what historical and other facts we need to know, what problems in relation to health, recreations, politics, ethics, religion, social conditions, economic conditions and other fields we shall be required to solve during our lives outside of the artificial school environment. Other things being equal, the most far-reaching and fruitful influence will be exerted by education which leads most directly to the reactions required in life as a whole. This new point of view in curriculum construction is obviously in harmony with the principles of transfer.

Transfer and Project Methods.—A second movement in education justified by the principles of transfer is concerned with the method of acquiring information, skill, reasoning ability and other reactions. It is a movement, in general, aiming at making methods of learning as similar as possible to those most suited to real life. It assumes that in life, persons are largely engaged in meeting practical problems, solving new issues, consummating various projects and carrying out numerous purposes largely on their own initiative. It assumes at least that life would be improved if persons could set up purposes and problems, plan means to consummate or solve them, find materials and information required to put the plans into effect and persevere in the endeavor until the project has been completed or the problem solved satisfactorily.

The facts of transfer obviously indicate that the surest way to acquire ability to solve important life problems and to consummate worthy projects and purposes is to begin early to do so. The more lifelike the problems, projects and purposes are, the greater the transfer from them to life will be; the more satisfactory methods of procedure exercised in dealing with them in school, the more helpful they will be in meeting the situations of out-of-school life. In several directions then, the facts derived from studies of the transfer of training have encouraged and justified movements designed to make education, in its choice of materials, methods and spirit, less academic, artificial and isolated and more closely related to the best type of real life. The school more and more seeks to help pupils to learn how to participate fully and effectively in all phases of modern life.

THE INFLUENCE OF EDUCATIONAL METHODS ON TRANSFER

In the experiments on transfer reported above, the pupils were given little guidance of the type that has been recommended in this course. The pupils who took part in the memory experiments were merely told to memorize the material offered. The pupils studying grammar were given assignments to learn. They were not conducted through experiences in which the solution of problems in grammar became means of extending and refining the techniques of generalizing and reasoning. In none of these experiments was much, if any, attention given to doing more than merely meeting the requirements to memorize certain assigned materials. In certain other experiments this rather narrow and formal sort of educational method has been compared with procedures which were designed to introduce and make effective certain general methods of study and to develop understanding of how and when to use them. A recent study (by Woodrow) of memorizing will illustrate the results.

The Influence of Teaching Approved Methods of Memorizing.—On the basis of initial tests in memorizing several kinds of materials, Woodrow divided his subjects into three groups of equivalent initial ability. One group, the Control Group, was given no training. A second group, the Practice Group, was given material to memorize without guidance or instruction. A third group, the Educated Group, was given practice in memorizing combined with careful instruction concerning good methods, and suggestions concerning how to put these methods into effect during the training period. Among the devices suggested were the use of the whole method, instead of the part; the employment of actual recitation instead of mere rereading; the methods of searching for and using rhythms, groupings and meaningful clues. The program followed by the two groups is indicated in the schedule at the top of page 441.

The transfer tests, given before and after practice, show the amounts by which the Practice Group and the Educated Group, respectively, exceeded the gains made by the Control Group.

	Units Gained Practice Group	Units Gained Educated Group
Learning poetry	0.3	6.1
Learning prose	0.8	7.5
Learning facts	0.2	7.2
Learning dates	1.3	8.8
Learning vocabulary	1.0	10.9
Average gain	0.75	8.5

The results of this study are very striking. *The Educated Group shows more than ten times as much transfer as did the Practice Group.* Even if these results cannot be duplicated by every teacher or in every kind of learning, they nevertheless point very forcibly to a moral, namely: The *general* effect of education is influenced greatly by

PROGRAM OF PRACTICE PERIODS

PERIOD	PRACTICE GROUP	EDUCATED GROUP
I	20 minutes: memorizing poetry	7 minutes :listening to exposition of rules 13 minutes: memorizing poetry
II	25 minutes: memorizing poetry	7 minutes: listening to exposition of rules 18 minutes: memorizing poetry
III	28 minutes: memorizing nonsense syllables	28 minutes: listening to exposition and illustration of rules
IV	20 minutes: memorizing nonsense syllables	5 minutes: listening to review of preceding period 15 minutes: memorizing non-sense syllables
V	19 minutes: memorizing nonsense syllables	9 minutes: attending to "blackboard talk" on meaning of secondary associations 10 minutes: memorizing non-sense syllables
VI	25 minutes: memorizing poetry	25 minutes: memorizing poetry
VII	20 minutes: memorizing poetry	20 minutes: memorizing poetry
VIII	20 minutes: memorizing nonsense syllables	20 minutes: listening to review of methods, and the situations in which to use them
Total time	177 minutes	177 minutes

the methods utilized. Transfer may be greatly increased by utilizing optimum methods. What, then, *are* the optimum methods?

Transfer and Methods Generalizing Information, Skills and Ideas.—In general, the optimum methods, to the best of our knowledge, are those suggested in preceding chapters. The problem is one of discovering the facts, skills and ideals that are most widely useful and then of conducting the educative process so that these reactions are developed in the most widely applicable forms. The educative process sketched chiefly in Chapter XI, is designed to enable pupils to detect and react to the subtle elements in various situations. It may be called a process of generalizing information, skill, ideals and purposes. But merely to tell a pupil that "he should generalize" is futile. Insight into new situations and ability to transfer reactions to them is brought about only by careful education in which various situations are properly introduced and the proper reactions exercised. As in the experiment just described, neither mere instruction nor mere practice is alone sufficient. Both must be utilized.

Some Reactions More Difficult to Generalize than Others.—Needless to say, it is more difficult to make some reactions widely applicable than others. It may be relatively easy to learn to recognize *squareness* wherever it appears but it is more difficult to learn invariably to realize *fair-mindedness*. It is relatively easy to learn to use such a device as learning by the whole method but not so easy always to be systematically analytic in various forms of reasoning. Even in the simpler cases, it usually requires some measure of adaptation before any fact or device can be properly used in a new setting. Indeed, it will be a mistake to assume that mastery of even the simplest methods in any one type of learning will insure its operation in others. Woodrow, in his experiment, wisely used two different but representative materials, poetry and non-sense syllables, and gave much attention to illustrating, exercising and reviewing the application of methods to each type. Even simple methods must be actively habituated and thoroughly understood to be of great use. The many subtle factors which compose the "problem," "practical," "scientific," "fair-minded" or "artistic" attitude are very difficult to develop to a state of wide applicability. They are rarely general or universal as the relative incapacity of most people to solve problems, or to be practical or scientific outside of their own specialty attests.

The Need of Broad Training.—A final application of these facts is that in so far as a complex form of behavior such as reasonableness, fair-mindedness or originality becomes general, it is necessarily the result of broad experience. When a man declares that he developed willpower by hoeing potatoes when he hated the task in childhood, or acquired originality by playing with toy blocks, or achieved reasoning ability by studying mathematics, or developed coöperativeness and leadership on the football field, we may feel assured that he is in error or, at least, very unusual. Any such experience may have contributed its bit, but in so far as such traits are a general characteristic of a person, and are acquired rather than inherited, they are the results of training in many phases of life. General development is broad development.

THE RELATIVE VALUES OF DIFFERENT SUBJECTS

There remains for consideration the possibility that certain school subjects and activities are intrinsically superior to others as a means of broadly developing mind and character. Thus it has been urged that some subjects provide exceptional opportunities for encouraging the growth and transfer of desirable behavior. It might be argued that shopwork is especially effective in developing originality and inventiveness; that mathematics, because of the clearness of its logic and definiteness of its tests, cultivates ability to reason, that Latin, because of its difficulty, schools concentration and persistence.

Of the many studies of the influence of training in particular subjects which have been made, some investigations by Thorndike are by far the most suggestive. He undertook to determine to what extent a year's training in each of many high-school subjects would increase ability in a series of tests of "selective and relational thinking" or reasoning. About 13,500 pupils in Grades 10, 11 and 12 were subjects. The studies were conducted in such a way as to show the *relative* influence of different groups of related subjects upon ability in the reasoning tests. The relative influences are indicated in the following table, which shows how much different groups of subjects exceeded or fell below, the *average* effects, made by the subjects in Group 7.

Group of Subjects	Relative Influence
1. Algebra, geometry, trigonometry, etc.	+3.0
2. Civics, economics, psychology, sociology	+2.9
3. Chemistry, physics, general science	+2.7
4. Arithmetic and bookkeeping	+2.6
5. Physical training, athletics	+0.8
6. Latin, French	+0.8
7. Business, drawing, English, history, music, shop, Spanish	0.0
8. Cooking, sewing, stenography	−0.1
9. Biology, zoölogy, botany, physiology, etc.	−0.2
10. Dramatic art	−0.5

Thorndike's comment on these results is: "The differences are so small and the unreliabilities are relatively so large, that the influence of the subject studied seems unimportant." The conclusion suggested, then, is that in representative high schools of today, a year's training in cooking, sewing, physical training or bookkeeping has about as much effect upon "general power to think" as an equal amount of instruction in algebra, civics, physics or Latin. Indeed, one subject is about as good as another.

The implication of these investigations is that no one subject, because of the intrinsic character of its organization or subject matter or procedure, has outstanding merit as an easy and sure means of developing ability to think in general. This conclusion should be considered in connection with Woodrow's study which showed that the influence of the learning depends greatly on the way the subject is taught and learned. Mathematics may be made a mere exercise in rote memory of barren facts, distasteful and largely futile, or it may be made an absorbing study of real life problems activating the finest techniques of reasoning and imagination. What the effects of studying a subject will be cannot be foretold from the name of the subject, or even from its historical prestige. The degree of transfer, to repeat, depends upon the kind of reactions that are exercised and upon the degree to which their application to new settings is provided for by guidance and experience.

THE RELATION OF TRANSFER AND ORIGINAL ABILITY

A significant outcome of Thorndike's investigation of the influence of high-school subjects upon "selective and relational thinking" in general was the fact that the amount of transfer made by pupils who were good thinkers to begin with was much greater than the amount made by poor thinkers. The pupils who were in the highest one per cent in the initial tests of thinking (that is, the best pupil in every hundred) made an average gain of 20.5 points on the final tests whereas the pupils in the lowest one per cent made an average gain of only 1.5 points. The best thinkers gained nearly fourteen times as much as the poorest. Now, the difference between the best and the poorest *subject*, as shown above, is only 3.5 points. Thus it is apparent that original ability to acquire facts, perceive relations and other subtle elements, to generalize and manipulate data in reasoning, far exceeds the advantages of one subject over others as they are now taught. A bright pupil will develop far more ability to think by studying the subject least valuable in this respect than a dull pupil will gain by studying the most helpful subject.

Thorndike's own conclusions from his studies suggest the causes of mistaken notions about the relatively great value of certain subjects in producing good thinkers. "The explanation of any large difference in general improvement of the mind from one study rather than another seems doomed to disappointment. The chief reason why good thinkers seem superficially to have been made such by having taken certain school studies, is that good thinkers have taken such studies, becoming better by the inherent tendency of the good to gain more than the poor from any study. When the good thinkers studied Latin and Greek, these studies seemed to make good thinking. Now that the good thinkers study Physics and Trigonometry, these seem to make good thinkers. If the abler pupils should all study Physical Education and Dramatic Art, these subjects would seem to make good thinkers. These were, indeed, a large function of the program of studies for the best thinkers the world has produced, the Athenian Greeks."

PRIMARY AND CONCOMITANT LEARNING

The results of these experiments should not be interpreted as evidence that it does not matter what or how anyone studies, or how anyone is taught. The results may be interpreted to mean, first, merely that all *subjects as now taught* are about equally useful as a means of improving thinking and, second, that when all pupils are taught about equally well, the differences in ability to think are largely due to differences in native endowment. It is still possible that all subjects may be taught to all pupils, bright and dull, far more effectively than they are now taught as means of improving not only ability to think and reason but also other desirable mental, emotional and volitional reactions. Indeed, some critics of present methods of teaching would probably conclude: "Well, these results are about what I expected. They show that teachers are chiefly concerned merely with getting pupils to study by routine methods the pages assigned in books on history, mathematics and so on. It doesn't surprise me that cooking and bookkeeping improve ability to reason quite as much."

The writer would expect Professor Kilpatrick, for example, to reach some such conclusion. He would expect him to repeat his criticism that teachers are far too exclusively concerned with the assigned lessons and far too little interested in "concomitant" learnings. By the assigned tasks is meant such lessons as practicing writing, learning to spell ten words, studying a chapter in the history, doing an experiment in physics. By concomitant learnings is meant many important outcomes that cannot be definitely or profitably assigned. It is futile to say to pupils: "During the study of the next lesson, Chapter X, I want you to improve your methods of study and reasoning; also your ability to judge and plan. I want you furthermore to increase your love of learning, your interest in education, your habits of neatness, accuracy and emotional control. I should also like you to improve your ideals of service and trustworthiness." These and other desirable outcomes of learning cannot be assigned like a chapter in a book. They must be developed in the course of activity directed, apparently, to other ends. Although they are acquired as concomitants of activities that can be assigned, they can quite as fully be made the objectives of education as the mastery of particular names and dates. The concomitant learnings are law-abiding and subject to control. They may be difficult to control but they are not uncontrollable.

The studies of transfer just reviewed show that no subject has any great advantage over others as the means of developing such concomitants as the techniques of reasoning. It is probable that no one subject or activity stands supreme as the means of developing such concomitants as fair-mindedness, self-reliance, emotional control, confidence, originality or any other type of reaction. Indeed, every consideration points to the belief that to insure such concomitant learning is the responsibility of every teacher of every subject. The responsibility cannot be placed on any one teacher or subject. If desirable mental, emotional, volitional, social, moral and other habits are to be developed, each learning situation must be made to contribute in some measure to their growth. As Kilpatrick has rightly insisted, the concomitant learnings in any subject are usually more important than the assigned learnings.

QUESTIONS AND EXERCISES

1. Do you remember any doctrines presented in preceding chapters which seem to be contradictory to the views of the present chapter on transfer?

2. "Skim" the contents of the preceding three chapters, picking out the sections which have a definite relation to transfer.

3, If one spoke English until 10 years old, then spoke only German for 10 years, would the ability to speak English decrease more or less than if one had not spoken at all?

4. A woman aged 30 and her daughter aged 6 came to the United States from France. Why, after two years of practice, does the daughter speak more perfect English (meaning here merely accuracy of articulation) than the mother? If both had secured the same training during the two years, which would probably have developed the larger English vocabulary (knowledge of meaning of words)? Explain.

5. Reread the description of Voelker's experiment on trustworthiness in the preceding chapter. How do the results of that study bear on the problem of transfer?

6. William James, in his chapter on "Habit," wrote: "As a final practical maxim, relative to these habits of will, we may, then, offer something like this: *Keep the faculty of effort alive in you by a little gratuitous exercise every day*. That is, be systematically ascetic and heroic in little unnecessary points, do every day or two something for no other reason than that you would rather not do it, and so, when the hour of dire need draws nigh, it may find you not unnerved and untrained to stand the test." Examine this statement critically and determine what the conditions would have to be for it to agree with the doctrine given in the text.

7. Would the Law of Effect have any bearing on James's statement? Would the implication of that statement be that subjects should be introduced into the curriculum merely because they are difficult or distasteful?

8. Compare the implication of James's statement with the following by Thorndike: "To study the distasteful that is known to be useful is of much greater disciplinary value than to study the merely distasteful. The habit of value is to *suffer that good may come*, not *to suffer wastefully*. It is in sacrificing for a greater good, not in mere sacrificing, that the mind gains. To suffer simply so as to stand suffering would be as foolish as to learn falsehoods so as to be able to unlearn them."

9. How do you suppose Thorndike would justify this statement: "The greatest disciplinary value of Latin would appear in the case, not of those who disliked it and found it hard, but of those to whom it was a charming game"?

10. Collect some statements from books on education, general reading, or advertisements which are based on erroneous notions of transfer. Criticize them.

11. Suppose it were found in a certain secondary school that the students who had studied geometry were better in reasoning in general than those who had not. Would you consider this satisfactory evidence that training in geometry was responsible for the greater ability in general?

12. Do you think some teachers secure a greater amount of transfer among their pupils than others do? How?

13. Show in detail how the training received in (a) athletic games, (b) grammar, and (c) psychology may be made to function in everyday life.

14. What reactions acquired in playing the piano would transfer to typewriting? To singing? What negative transfer might take place?

15. On the basis of the *general* value of studies, what changes would you recommend in the curriculum of the high school from which you were graduated?

16. Will reading good literature contribute to your ability to write? To get the greatest transfer just *how* should you read?

17. How would you train a child to meet emergencies (as in cases of fire, accidents, drowning, etc.)? To what degree will mere knowledge of what to do function in face of an emergency?

18. What subjects are especially useful to develop general open-mindedness or freedom from prejudice and superstition?

19. What are some concomitant learnings that might be secured in reading? In music? In spelling? What would have to be done to secure them?

20. What is the "project method" and what are its merits and defects?

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CHAPTER XIV

FACTORS INFLUENCING EFFICIENCY

In preceding chapters attention has been centered upon the learning process. Most of the suggestions previously made concerning means of increasing proficiency have been applications of the fundamental laws of learning. In the present chapters we shall consider the influence of a variety of external and internal conditions, especially those factors which may be enlisted to increase efficiency in learning and performance by sagacious classroom management. We may begin with a discussion of interest and readiness concerning which some comments have already been made.

Interest and Readiness

Interest Not a Power or Entity.—Interest is a term much used in education. It is a commonplace in educational circles that no factor equals interest as a means of stimulating and sustaining activity and learning. It is often said that if the pupil's interest in attacking a task can be aroused the problem of motivation is solved and effective learning is secured. While such statements are in a general way true, they often lead to the mistaken assumption that interest is a sort of power, entity, faculty or thing-in-itself. Interest thus becomes a mere mystery, —an evasive magical potency. What, then, really is interest?

Interest Is a Symptom of Effective Adjustment.—Most of us will declare that interest, like effort, is something that one is conscious of. It is something one can *feel*—and it feels good. Interest is really not a power or an entity which generates energy but a *symptom. It is in brief, a symptom of a favorable adjustment of a worker to his work.* It is not the *cause* but the *result* of a favorable adjustment of a person to his task. In this sense interest is like fever or chills. Fever and chills result from and are caused by unfavorable internal conditions which we call disease; they are not the causes, they are the results of disease. Interest during work is a sign that one's work is going on favorably just as the fever is a sign that things inside are going on badly or that boredom is a sign that one's adjustment to one's task is not optimum. Interest, then, is to be sought not because it is some single potency which makes an activity inviting and agreeable but merely because it is a sign that many other things which are essential to favorable activity are actually in effect. Since our primary concern at present is to ascertain what makes study and other forms of school learning interesting, we must seek to discover the nature of these many things. Interest is, in fact, the result of putting into effect many things, each of which contributes something to a happy relation between the pupil and his learning activities.

Interest and Success.—Some of the factors which tend to make an activity interesting have already been mentioned. In Chapter VI we noted that activity which tends to satisfy one or more of the dominant human cravings is enjoyed. Now an activity which is unsuccessful, which results in failure to get ahead or to remove an obstacle,—effort which leads to error rather than achievement—can hardly satisfy any fundamental craving. Activity which is futile and misleading can scarcely appease hunger or thirst or secure social approval or result in acquisition of goods or satisfy any other desire. On the other hand, activity which leads to the successful completion of the tasks undertaken, whether the task is to master the words in spelling, to get the right answers in arithmetic, to improve the quality of writing, to put up a good defense of one side of an issue in civics or to paint a respectable picture in arts, such an activity tends to satisfy several cravings. Such activities, other things being equal, become desirable and interesting and tend to be repeated. The first step in developing zeal and interest in an activity, then, is to see to it that the activity is pursued successfully.

Interest and Ability.—Interest then is a result of ability rather than a cause of it. A pupil will not long maintain an interest in an activity which brings only difficulty, errors, failure, subordination to rivals, ridicule and scorn. Few educational requirements are more important than the need of adjusting the work to the abilities of particular children so that each can make maximum progress. A task may be too easy as well as too hard. Merely twiddling the thumbs is easy but not interesting; it is not mere success but successfully overcoming difficulties, that is interesting. This matter of adjusting activities to the abilities of the individual child so that his achievements may be maximum is so important that we shall devote several later chapters to it.

Interest As Related to Ability and Capacity.—In passing, we should note that our statement was that interest depends upon ability or proficiency. We stated several times previously that ability depends, in considerable measure, upon capacity or aptitude; it depends upon one's native equipment for learning. Does it therefore follow that interest depends upon native aptitude? Yes! but obviously indirectly. In some cases, furthermore, the distinction between ability and capacity is important. Take the case of the pupils in the first grade who have not yet learned to read. Some have abundant capacity—intelligence, visual acuity, linguistic aptitude—whereas a few may still be lacking sufficient capacity to learn to read readily. Now, it does not follow that those capable of learning to read easily will have a strong interest in reading and the others little or no interest *before they have acquired any ability.* Interest results from successful experience in reading; disinterest from unsuccessful effort. Those who have the capacity will develop interest—if all other factors are favorable—as they acquire ability; those who lack aptitude—other things being equal—will fail to acquire interest if they cannot acquire ability. A child's notions concerning whether he will like reading before he has tried to read are usually quite unreliable guides. Hence, tests of capacity for learning to read and to acquire other abilities (which we shall discuss in later chapters) are far better means of predicting interest than a child's own foresight of his interests.

Interests and Purposes.—While it is true that, other things being equal, an activity which one can do successfully tends to become interesting, and therefore tends to be pursued with zeal, mere proficiency is an insufficient guarantee of interest and an unsatisfactory educational aim. Activities which one can do well can be further infused with interest if they can be enlisted as the instruments of carrying out dominant life purposes. A purpose, as we said in Chapter VI, is an urge toward some consciously appreciated or foreseen goal. No one finds life so dull and listless as a person who has no dominating purposes in life. A woman of great proficiency whose only life purpose was bringing up well a family of children, became bored to the point of utter wretchedness after this purpose had been fulfilled at the age of fifty. Nothing was interesting any longer until she developed and put into effect a new purpose—that of educating less proficient parents in the care and education of their children. In an age when the organic cravings of hunger and the like are easily satisfied, it is essential to acquire and pursue some definite and far-reaching purposes. The danger of depending solely on one alone has just been illustrated. Several are better. Needless to say, one's dominant purposes should be useful to society as well as to one's self. They should also be purposes which one may reasonably expect to carry out. A person's several purposes should be compatible, and not conflicting. When tasks that one can do well are seen as means of furthering one's dominant objectives, they become doubly interesting. Conversely, one of the most effective ways of giving zest to an activity is to make it apparent that such work may lead toward the fulfillment of really vital aims.

Conclusions.—In summary, we may say that interest is the result, and therefore, the symptom of a certain happy relation between a worker and his work. A primary source of interest is the ability to do a thing well—to pursue an activity successfully. But, for interest to be wholesome and persisting, it must spring from an activity that serves some purpose. To *serve* a purpose, an activity must satisfy some need or craving and to *be* a purpose, a need must be felt or realized and its function foreseen. Perhaps the most succinct statement is this: *The most interesting activities are those which successfully further the fulfillment of one's dominant purposes.* To make an activity interesting to a pupil, the main thing is to see to it that the activity is pursued successfully and that it serves some worthy, and persistent, rather than trivial, and momentary, purpose. With this general emphasis upon major purposes in mind we shall take up a number of minor means of increasing efficiency or success in an activity.

THE INFLUENCE OF HABITS OF WORK

Efficiency may be increased by establishing various serviceable habits and attitudes. Efficiency is sometimes low because of difficulties in making a beginning upon a task. Work and study are often difficult to begin even when they are related to prominent purposes and are interesting after they are under way. One investigator (Starch) who sent a questionnaire to a group of college juniors and seniors found that a large proportion mentioned inability to get the work under way as one of the most serious sources of difficulty. Perhaps the dictum "well begun is half done" is psychologically sound. At any rate, since one cannot be efficient in a task without starting it, we should consider, first of all, the methods of overcoming the initial inertia.

The Influence of Habits.—The cause of inability to overcome the initial inertia—omitting such obstructive conditions as illness, fatigue, excitement, etc.—is then not so much laziness, indifference or lack of "will power" as the inhibiting effects of positive habits of doing or thinking of miscellaneous other things at the time, that is, habits of delaying the beginning. The remedy, when the time for starting work arrives, is to make a start, to go through the motions of work. If the task is to study a book, immediately and without stopping to think of anything else, walk to your desk, take your working position, open the book and start to read. If the task is writing a composition, go to the working place, take pencil and paper and start to write. Even if you can do no more than go through the motions, you will find that, by giving the work-stimuli a chance, they will soon begin to induce productivity and interest. The difficulty in getting started usually comes from permitting exceptions to occur until the habit of "dillydallying" becomes stronger than the habit of really starting. To avoid forming the undesirable habit never let an exception to starting definitely and without deliberation occur. The efficient habit, once practiced continually, soon becomes as comfortable as the habits of delay and indecision.

"Warming Up."—The distaste for beginning some tasks is probably increased by the sluggish and inferior type of performance which may appear before the worker gets "warmed up." It is a common opinion among college students and others that in every activity one must go through an unproductive "warming-up" period. While this is true of many muscular activities, it is not true, experiments have shown, of many mental activities. Indeed, in most types of mental tasks that have been studied experimentally, the performance is likely to be at a maximum from the start *if the subject makes a vigorous beginning.* The period of low efficiency at the start is often largely of our own making. We do badly because we think we are going to be inefficient. Efficiency depends greatly, then, upon our habits of working.

In the schools, care must be exercised to provide the conditions and establish the habits conducive to an effective beginning of activities. The teacher must avoid reprimanding pupils who display the same inertia that adults do. A scolding, as the principles of simultaneous stimulation will suggest, not only adds a further distraction but may attach annoyance to the beginning-a-lesson situation. By clearing the surroundings of distracting influences and providing the materials which suggest work and by following a schedule of activities of suitable character, circumstances are provided which favor the formation of good habits.

Regularity and Variety in Periods of Work.—Interest and efficiency can be increased by establishing time and place work habits. If the pupils become accustomed to having a play period at 10:30, they come to be, at that hour, highly ready for play and unready for arithmetic or spelling. The craving for vigorous play having been appeased, pupils are left more ready than otherwise for less vigorous activities. Time habits thus influence interest. Every teacher knows that children, accustomed to read history in one room, are less likely to study the same material with interest and efficiency in the room in which they usually play. Place habits are therefore of some importance. A well-conceived schedule of school activities is one means of furthering interest and efficiency. In organizing a schedule, several factors should be taken into account. Some of these we shall now consider, taking up first the influence of time factors.

THE INFLUENCE OF TIME FACTORS IN CLASSROOM MANAGEMENT

In this section such questions as the influence of continuous work, the optimum length of a study period, the optimum interval between periods, the distribution of reviews and related problems will be considered. Only the facts relating to rather gross, mechanical features of the practice or study period will be taken up here. The problems raised are an illustrative and not a complete series. Some related considerations will come up in later chapters. With as many different subjects as there are, and with as many variations of the length of assignments, study periods and intervals as are possible, it is apparent that an enormous number of investigations must be conducted before all of the facts are known. While the number of studies is large, crucial evidence is lacking in many instances; and in some subjects no investigations have been made. Guidance, however, had better rest upon the implication of such experimental results as are available than upon mere opinion. The statements in the following sections are offered subject to revision in the light of results of future research rather than as final principles.

Continuous Muscular Work.—The effect of continuous work in a function upon efficiency in it, as measured by the amount and quality of the product (words written, facts learned, etc.), varies considerably with the function.

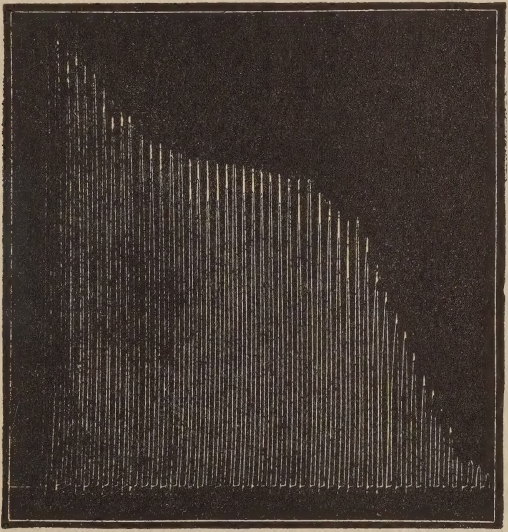

FIG. 32.—THE VERTICAL LINES INDICATE THE RELATIVE DISTANCES THROUGH WHICH A WEIGHT OF 6½ POUNDS IS PULLED BY THE MIDDLE FINGER OF THE RIGHT HAND. Contractions were made at intervals of two seconds. (From Howell's *A Textbook of Physiology*, 5th Edition.)

In the case of hard muscular work the decline in efficiency is rather steady and pronounced. Figure 32 shows the relative distances through which the middle finger pulls a load of about six and a half pounds making a pull every two seconds. The muscle soon is incapable of lifting the load although it is not entirely exhausted as shown by the fact that it can still lift smaller weights. A rest of about two hours would be required before the muscle could repeat the original performance. If sufficient rest is given between the contractions, the muscle will lift the load a much greater number of times. If a muscle in some other part of the body, the other arm, for example, is working at the same time, the finger loses its strength more rapidly possibly because of the fatigue products circulating in the blood. Loss of sleep or food, and doses of alcohol and certain other drugs, decrease the efficiency of the muscle, whereas sugar, adrenalin, and certain other chemicals increase efficiency.

Muscular work of this sort uses up definite materials such as glycogen and develops by-products such as carbon-dioxide, which together reduce the capacity to function. Unpleasant sensations, pain, or so-called "feelings of fatigue" are also produced, along with definite impulsions to cease the work.

Continuous Work of the Neurones.—The effect of continuous work by isolated neurones may be observed experimentally. One method employed is to dissect from a freshly killed frog a large muscle with a long motor nerve attached. Such a "nerve-muscle preparation" can be kept alive for a long time. If the stump of the nerve is stimulated by an electric shock, the nervous impulse thus occasioned discharges into the muscle and causes a contraction. If contractions are provoked rapidly, the muscle soon fails to respond. Whether the loss of capacity is due to fatigue of the nerve or to fatigue of the muscle may be determined by an experiment. If a bit of the drug, curare, is placed on the nerve near the muscle, the nerve impulse is blocked at that point so that it fails to activate the muscle. It has been found, however, that the impulse passes along the nerve as far as the point at which the drug is applied, *i.e.*, that the neurones are conducting as under ordinary circumstances. Investigators have found that even when the nerve is stimulated several times per second for ten hours or more, removal of the effects of curare results in the renewal of the muscular contractions upon stimulation of the nerve, thus demonstrating an extraordinary resistance to "fatigue" on the part of nerves as compared to the muscles.

Continuous Mental Work.—Mental work usually involves the activity of muscles as well as neurones of the central nervous system. In reading, the muscles of the eyes, at least, are engaged; in writing compositions and in arithmetic, the muscles of the eyes, hands and arms are active. Even in "mental" arithmetic, spelling or ordinary thinking, muscles of the eyes, the vocal organs and probably other parts of the body are involved to some extent. And in all types of mental work, the maintenance of the body's position depends upon muscular adjustments. Thus, what we call "mental fatigue" is in part the result of muscular work and identical with muscular fatigue.

When one has been working continuously at spelling, arithmetic, reading, composition or some other mental task, he may become aware of a group of sensations which technically have been called "feelings of fatigue," usually unpleasant in character. Feelings of fatigue are, in a large measure, sensations from muscles, tendons and joints, and include feelings of numbness, aches and pains from the eyes, head, back and other parts of the body. With these are fused other sensations derived from visceral, arterial and other organic conditions. The whole constitutes the familiar feeling of fatigue which is usually accompanied by impulses to stop working. If the work is continued it becomes tedious or distasteful.

The progressive course of feelings of fatigue and annoyance produced by continued work is pictured roughly in Figure 33, which is based upon the judgments of a group of adults obtained during four hours of continuous work in grading English composition. Highly interesting at the beginning, the work became progressively less pleasant, until at the end of the fourth hour it was clearly distasteful.

Feelings of fatigue and loss of interest are commonly accepted by workers as indicative, at least approximately, of a decreased state of efficiency. But that these symptoms are extremely misleading has been found repeatedly when the quantity and quality of the output has been measured during periods of continuous work. In Figure 33, the distastefulness of the work in the case of grading compositions, for four hours continuously, is plotted together with the output. The loss of ability is not nearly as great as the loss of satisfaction in the work.

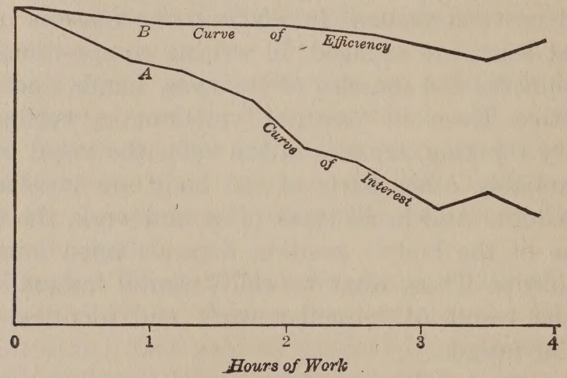

FIG. 33.—CURVE A SHOWS THE RAPID LOSS OF ZEAL OR INTEREST IN GRADING ENGLISH COMPOSITIONS DURING A PERIOD OF FOUR HOURS. The curve is an average for five subjects. Curve B shows the loss in efficiency, represented by a combined score for speed and quality of work, during the same time by the same subjects. The greatest loss of efficiency (near the end) is about 7 per cent. (Modified after Thorndike.)

Many investigations of continuous mental work have yielded similar results. Two or three hours of continuous work at maximum effort produces a temporary decrease in the product of not over ten per cent, and in most functions less than that. By a temporary decrease is meant one which is curable by a rest of an hour or less. Of course, the curve of work is marked by all sorts of fluctuations, some of them peculiar to particular individuals, and efficiency may drop more decidedly if the worker eases up. But on the whole, continuous work in mental functions shows a small loss in output as compared to that found in continuous muscular work. If we make mental work as difficult as we can, taking for our task the mental multiplication of such numbers as 8372 and 3458, for example, we find that, as demonstrated by one experimenter (Arai), it is possible to keep it up for twelve hours at a stretch. The result of long-continued difficult mental work is thus in sharp contrast to the effect of hard physical work. While feelings of physical fatigue may be fair indices of physical capacity, they yield by no means reliable evidence of mental efficiency.

So far as mere loss of possible efficiency is concerned, there is little to urge against long-continued work of the same sort. But what of other effects? Too lengthy application to a task *may* make the work uninteresting or positively repugnant. When the work becomes distasteful or exasperating, it probably indicates an unfavorable organic stirring-up somewhat similar to that observed under emotional irritation or excitement. This general state is indicative of a considerable organic wear and tear which may become injurious if long continued. But it is the repugnance, exasperation, excitement or worry produced by mental work rather than the work itself which is harmful. If one can school himself to maintain interest and enjoyment in the task, the ill effects of long and hard mental work may be tremendously reduced. There are, of course, limits to the amount of mental work one may safely do because of the muscular fatigue and the deprivations of recreations, exercise, rest and sleep which too persistent work may bring. Just how long a person may safely do mental work depends partly upon his general strength and stability, partly upon his susceptibility to excitement and worry and partly upon his interest.

The "feelings of fatigue" are in part, if not mainly, the results of muscular activity and strain. Much may be done to lessen unnecessary and often damaging fatigue, particularly of eye and hand. For example, the task of copying problems to be computed in arithmetic or algebra, facts to be learned, etc., is not only harder work, minute for minute, than computing or memorizing, but much more monotonous. It is, moreover, as unnecessary as it is fatiguing. Less worry about the disastrous effects of "mental fatigue" and more attention to muscular fatigue of eyes, hands and the body is one suggestion which the experimental studies of mental work have to offer.

Loss of Sleep, "Hazing," etc.—Other types of experimental evidence on the remarkable capacity of the organism to adapt itself to unusual conditions have been obtained. For example, students during periods of from thirty to forty-eight hours without sleep, although subject to pronounced "feelings of fatigue" and other uncomfortable symptoms, were nevertheless able to perform mentally as efficiently and learn as effectively as under ordinary conditions (study by Robinson). During a fast of thirty-one days, a man (studied by Langfeld) showed no appreciable loss of mental efficiency and ability to learn, although the decrease of bodily weight and strength was great.

In the study mentioned in Chapter V (Knight and Remmers) some of the subjects during five days were given Hinkle's pills, not permitted to shave or bathe, were forced to carry with them everywhere weighty articles, were "paddled" with barrel-staves, forced to eat raw liver ("ostensibly dog-meat"), were subjected to realistic but fake "brandings" and otherwise hazed, were allowed only one or two hours of sleep in twenty-four, and during the twenty-two waking hours were required to do menial work about the house, or go "frequently" on long hikes in addition to carrying on their regular university work. Despite all of these hardships, under strong motivation, they appeared to do simple mental work as well as usual. Such facts bear witness to the remarkable stability of the mechanisms involved in well habituated mental activities. It is surprising that these functions, which may be so readily allowed to operate below maximum in the absence of incentives, remain unimpaired in efficiency, during and after such extreme deprivations and exertions. The facts attest, also, to the remarkably effective and facile adaptability of the human organism to unfavorable conditions imposed upon it.

All of these experiments show that a person *can*, if he exerts himself, maintain efficiency in work of the usual school type for a long time although it is unnecessary and inadvisable. Let us now turn to certain studies which seem to indicate the nature of optimum periods of practice or study.

The Length of Practice Periods.—How long should a learner continuously study geography, psychology or mathematics, or continuously practice writing, typewriting or sewing? The results of a large number of investigations are not altogether in harmony, but they favor periods of thirty minutes or less as compared to longer periods. The optimum length of the practice period varies considerably, however, with the age, interest and stamina of the learner and with the nature of the function practiced. We can offer only a few typical results.

In one investigation of learning in "substitution"—a rather difficult function in which the letters of words are translated into other symbols by the use of a code—a group of subjects practiced for sixteen days, using periods of the same length, and then were divided into four groups, one practicing fifteen minutes a day, another thirty, another forty-five and another sixty. The improvement in speed in the second practice period was then compared with the increase in the first period when all were practicing in periods of equal length. This is shown in the accompanying table:

THE RELATIVE IMPROVEMENTS IN SPEED OF SUBSTITUTION WHEN THE SAME AMOUNT OF PRACTICE TIME IS DIVIDED INTO PERIODS OF DIFFERENT LENGTHS

(From Pyle)

GROUP	LENGTH OF PERIOD	RELATIVE IMPROVEMENT
A	15 minutes	22.3 per cent
B	30 "	36.1 per cent
C	45 "	25.0 per cent
D	60 "	14.8 per cent

The thirty-minute practice period yields greater returns per unit of time than longer or shorter lessons. The sixty-minute period is especially unproductive.

Other investigations of memorizing, archery, typewriting and arithmetic have shown in the main, that continuous practice longer than thirty minutes is relatively unproductive, as are very short periods of ten minutes or less. The facts vary somewhat with the functions, but, roughly, periods from twenty to thirty minutes are most desirable for adults in practice or study of difficult functions such as typewriting, learning a vocabulary, memorizing formulæ in mathematics, etc. In practice or study in which the same details are not constantly employed and in which the task or content changes, as in baseball or history, the period may be considerably longer.

For children, the optimum practice period is shorter, depending on the age of the child as well as the function. In practice of difficult motor acts, such as writing, or memorizing as in spelling, a five-to-ten-minute period without cessation is long enough for children of six or seven. The usual procedure is to allow young children a great deal of freedom to rest or change, with rarely more than twenty minutes given consecutively to the same general topic, *i.e.*, reading or drawing. The length of lessons is gradually increased as the pupils become older.

The Distribution of Practice.—If a learner has at his disposal seven hours a week for practice in typewriting, playing the piano, singing, etc., how may the time be most fruitfully distributed? Should he work continuously on one day for seven hours, or in half-hour periods—which, as we just found, are optimum—with intervals of a half hour, an hour, six hours or twenty-four? Experiments have not yielded entirely conclusive results, and but few functions have been tested at all. There has been a rather consistent indication, however, that by breaking up the available time into periods of thirty minutes, or somewhat less, separated by intervals of from thirty minutes to twenty-four hours, the best returns are secured. Thus it would probably be preferable to make use of the seven weekly hours by practicing twice a day for thirty-minute periods; or, if but three and a half hours were available, half-hour daily periods would be advisable. That is, one should make the practice periods no longer than thirty minutes and distribute them at fairly uniform intervals, of not more than twenty-four hours, at least, in the case of difficult and repetitive learning. If only two hours per week are available, it would be desirable to divide the time into daily lessons of seventeen minutes each. When this scheme of distribution reduces the length of the lesson to fifteen minutes or less, it would probably be better to increase the intervals to forty-eight hours rather than make the practice period too brief.

The problem is slightly different when the task is to learn a speech, a short vocabulary, a particular musical selection, or a multiplication table. Should one learn such short lessons at one sitting, or at several sittings with intervals between? But little experimental work has been directed specifically to this problem. In one study (by Pieron), a series of items to be memorized was read from start to finish at a constant rate, and then repeated at fixed intervals until mastered. The time required when repetitions were made at intervals of twenty minutes or more was much less than the time required for nearly continuous study. Most other evidence available on this point indicates also that distributed practice is economical.

The Distribution of Reviews.—When material has been learned sufficiently to be recalled, how should further practice be distributed when it is desired to have the facts permanently learned, as is often the case with certain facts in history, poems, rules of grammar, operations in mathematics, etc.? Should the overlearning be carried out at once or should it be distributed over periods of weeks or months?

The evidence bearing on this problem is insufficient to justify a confident statement, but it indicates that one should overlearn somewhat at the beginning and leave the remainder of the overlearning to reviews at constantly increasing intervals. For example, the first review, a relatively long one, should be made within forty-eight hours; the next review, somewhat shorter, a week later; the next, shorter still, three weeks later; the next, two months later, followed by other reviews at intervals of five months or more.

Actual counts of the frequency and distribution of particular facts in textbooks of history, arithmetic, algebra, etc., show that usually little attention has been given to effective organization for learning in these respects. (See Figures 34 and 35.) Some of these books concentrate

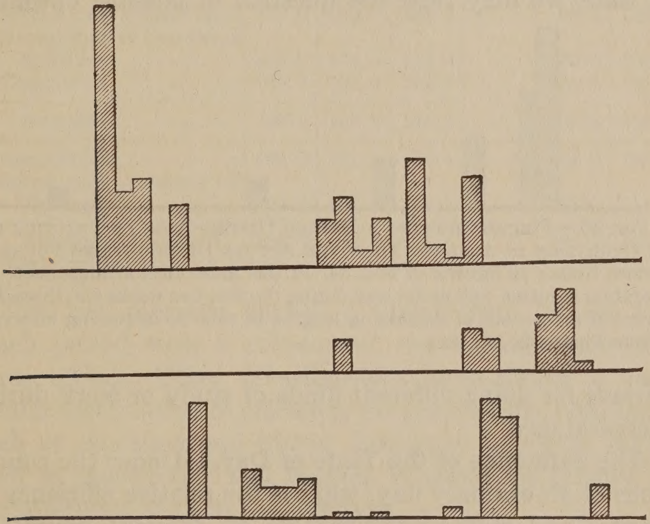

FIG. 34.—THESE THREE FIGURES SHOW THE DISTRIBUTION OF PRACTICE IN REMOVING NEGATIVE PARENTHESIS DURING A YEAR IN THREE DIFFERENT COURSES IN ALGEBRA. The width of each single rectangle represents ten successive pages in each book, or roughly, a week of time. The practice as shown by the top figure is too irregular; the long gap comes too early. The second figure would be better if reversed. The third is haphazard. See Fig. 35 for a better distribution. (From E. L. Thorndike, *Psychology of Algebra*, New York, The Macmillan Company.)

practice almost entirely at one point; some have reviews with too long gaps between; many show a haphazard arrangement, differing greatly for different facts presented in the same book. Careful organization with respect to the amount and form of distribution of practice adds considerably to the task of constructing texts, but subtracts greatly from the learning task of students.

In connection with the placement of practice and study in time, we may raise the question of possible optimum periods for doing different kinds of study or work during a typical day.

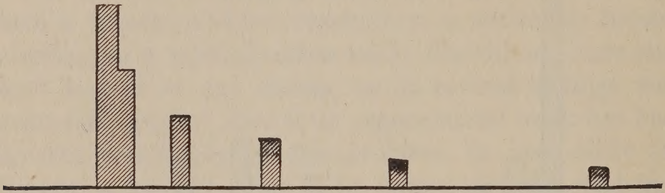

FIG. 35.—FIGURE SHOWING A BETTER DISTRIBUTION OF PRACTICE FOR AN OPERATION IN ALGEBRA THAN THE ACTUAL DISTRIBUTIONS FOUND IN THREE BOOKS AS SHOWN IN FIG. 34. In this more ideal arrangement, the operation is gotten well under way during the first two weeks and thereafter reviewed for periods of decreasing lengths of time at increasing intervals. (From Thorndike, *op. cit.*)

The Influence of the Time of Day.—Under the conditions of an ordinary day, what is the relative efficiency in mental and motor performances at different hours? In one investigation, the pupils of several grades were repeatedly tested in representative tasks at different periods until the accumulated results gave a fairly accurate measure of achievements resulting from maximum effort at different hours of the day. The results are given in the table on page 471.

In the more strictly mental functions such as addition, multiplication, visual and auditory memory, recognition and completion, efficiency is lowest in the first and highest

Variation in Efficiency during the Day

(From Gates)

The Achievements at the Several Hours Are Proportional to That at the 9–10 A.M. Hour Which Is 100.0 in Each Case. Average Results for 240 Pupils from Grades 5 and 6.

Time	9–10 A.M.	10–11 A.M.	11–12 M.	12–1 P.M.	1–2 P.M.	2–3 P.M
1. Addition	100.0	102.4	104.2	.....	102.3	103.0
2. Multiplication	100.0	101.9	105.1	.....	100.9	103.0
3. Memory for Auditory Digits	100.0	105.9	106.7	.....	99.4	102.4
4. Memory for Visual Digits	100.0	103.2	109.2	.....	99.1	103.4
5. Recognition of Non-Sense Syllables	100.0	104.7	105.3	.....	100.0	103.7
6. Completion	100.0	105.0	109.7	.....	106.2	108.8
Average	100.0	103.8	106.7	.....	101.3	104.1
7. Cancellation	100.0	101.8	104.4	.....	104.9	105.5
8. Speed and Accuracy of Tracing	100.0	104.6	106.7	.....	109.5	111.2
Average of 7 and of 8	100.0	103.2	105.6	.....	107.2	108.4

in the last morning period. A slight drop follows the lunch period with a subsequent rise between two and three o'clock. Other investigations have shown a very similar distribution of efficiency for gross bodily functions, such as shoveling and lifting. Efficiency in motor skills, such as cancellation and tracing, is somewhat greater in the afternoon than in the forenoon.

Similar average results were obtained from a group of college students tested at all hours, except noon, from 8 A. M. to 5 P. M. An interesting feature of this investigation was the disagreement between the distribution of actual ability and the distribution of self-judged ability. Most students were quite mistaken about the hours of their maximum efficiency, doubtless because they were misled by feelings of fatigue which were often most acute at the periods of highest efficiency.

One thing is quite certain: the ordinary work of the school day is not so severe as to reduce efficiency perceptibly. In fact, achievement is higher at nearly every other hour than it is at the beginning of the day although the differences are small. Aside from the suggestion that such functions as writing, drawing, or other light work requiring speed and accuracy of movement might well be done in the early afternoon period, it would appear to make little difference at what hours mental work is pursued.

Influence of Variety.—All of the foregoing suggestions may be put into effect in a program which provides for regularity and variety in the arrangement of school work. Although high efficiency can be maintained for a long time when necessary, the optimum length of a practice or study period is relatively short. Frequent changes are therefore advisable. Such changes should be made so as to provide variety in the kinds of activity taken up in order during the day. A well ordered program provides mental work, light muscular skills like drawing, heavier muscular activities like athletics or shopwork, etc., in a sequence which relieve tensions, fatigue and boredom. Such a sequence will increase both interest and efficiency.

THE INFLUENCE OF EXTERNAL CONDITIONS

We have already mentioned the tendency of individuals to form place habits of work. Place habits consist of many subtle adjustments of the organism to the surroundings, to things in the field of view, to noises and other physical conditions. To indicate how remarkable is our capacity to adjust to variations in external conditions, the results of a few experiments will be cited.

The Influence of "Bad Air."—It is popularly believed that in poorly ventilated rooms, carbon dioxide and other toxins from expired air result in drowsiness, lassitude, headaches and loss of efficiency. Pure air contains about 21 per cent of oxygen, 78 per cent of nitrogen and 0.03 per cent of carbon dioxide. In a very crowded and ill-ventilated schoolroom the carbon dioxide may be increased to 0.3 per cent and the oxygen decreased to 19 per cent, but these changes are insufficient to produce the effects ordinarily observed. When the air is cool, of favorable humidity and in movement, the oxygen content must be reduced to 2.4 per cent before ill effects are produced. When the air is hot and of unfavorable humidity, the ill effects are not relieved by breathing pure air through a tube from the outside. High temperature or humidity or both, then, rather than low oxygen content and expired matter, seem to be the causes of discomfort.

Temperature and Humidity.—The influence of stale air, high and low temperature and humidity in various combinations has been studied by Thorndike and other psychologists working under the auspices of the New York State Commission on Ventilation.

It was found that adult subjects when urged to do their best could perform quite well and improved in efficiency quite as much when working in hot, humid, stale and stagnant air (temperature 86° Fahrenheit, humidity 80 per cent, with no fresh air and no movement in the air) as when they were working under "optimum" conditions—namely, a temperature of 68° Fahrenheit, 50 per cent relative humidity and 45 cubic feet of outside air per minute for each person. It was furthermore found that when the subjects were given very uninteresting work and were given no special incentives to do well, they still did as much and as well when working eight hours a day in the hot, humid and stale air as when working under optimum conditions. Finally, when individuals were given their choice of doing mental work, reading stories, resting, talking or sleeping, they did quite as much work when the temperature was 75° as when it was milder, 68° Fahrenheit.

The influence of extremely low humidity, with temperature kept constant at 75° Fahrenheit, was found to have no perceptible effects upon efficiency or improvability. A squad practicing arithmetic, typewriting and other functions during the regular working-day, and under ordinary motivation, with the humidity reduced to 20 per cent, improved as rapidly as a squad working under the "ideal" degree of humidity, 50 per cent (Stecher).

The atmospheric conditions which are encountered in ordinary life, then, however uncomfortable some of them may be, have no appreciable effect upon efficiency in performance, or on improvement in mental and light motor work when moderate motivation is present. Whether long-continued exposure to very hot, very moist, or dry air would occasion a good deal of wear and tear on the body or injure health, is another problem not as yet solved. The results of the psychological investigations indicate merely that if severe atmospheric conditions, as in midsummer, must be faced, one may as well be cheerful. At least, it is unlikely to be too hot to make mental work unprofitable. It is possible to learn as well when it is hot as when it is cool, when it is moist or dry, as when the humidity is moderate.

The experimental studies have a bearing on the perennial topic of the effects of weather and climate upon human feelings and efficiency. That human beings do become adapted rapidly to the most forbidding climatic conditions of the globe is not surprising in the light of experimental studies in which adjustments are effectively made to abrupt and extreme changes in humidity, temperature and staleness. While climate and weather include in addition to these factors others such as density of the atmosphere, light and possibly electrical conditions, the probability is that adaptation to these is equally facile.

Although the human organism is capable of maintaining high efficiency in learning and performance under extreme atmospheric conditions, such conditions are to be avoided whenever possible. The school should attempt to maintain what is believed to be optimum conditions, namely, a temperature of about 68° Fahrenheit, 50 per cent relative humidity and a circulation of 45 cubic feet of pure air per minute for each person.

Illumination and Color.—The most essential feature of favorable illumination is an evenness of distribution of light, especially the absence of glare or contrast in the field of view. Artificial or window light should therefore come from above, behind or at the sides. Contrasts in walls and hangings, glistening paper, or polished instruments contribute to eye fatigue. A second desirable feature is illumination of moderate intensity. Lights are more often too bright than too dim. Particularly unfavorable intensities and brightnesses are often produced by the use of high-power electric lights. A soft even light from indirect or semidirect systems is most satisfactory.

There are many opinions concerning the effects of colors of lights or surroundings on efficiency, disposition and health, but the findings of experimental investigations have been mainly negative. The most significant difference between light from an uncolored globe and light from a colored globe is that the colored light is less intense, since the colored glass absorbs some of the rays. It has been found (by Pressey) that the more intense light is more stimulating, but the difference is small. What little is gained by means of the stimulating effect of intense light is probably more than compensated for by its fatiguing effect upon the eyes. Colored glasses are restful only because they reduce light intensity. It makes little difference what particular color is used.

Auditory Distractions.—Just as the organism becomes adapted to wide differences in light or temperature, so it becomes adapted to persistent sounds of the street, conversation, rattling of typewriters or the roar of machinery. When adults are well adapted to a working condition, new distractions are apparently at first disturbing, although they may have little effect on the output if interest or motivation is excellent. Experiments conducted in the laboratory (by Morgan) indicate that when a subject is well adapted to a working condition, the introduction of a new disturbance causes but a slight and temporary decrease in efficiency, although it may be decidedly annoying. The subject soon arouses himself to overcome or adjust to the noise. His output is then kept up to the norm, often actually surpassing it, but more than the usual amount of energy is consumed. He may pound the typewriter keys harder, grit his teeth, articulate and contract various muscles. These superfluous activities drop out gradually as adjustment is perfected, just as irrelevant reactions tend to be eliminated in all forms of trial-and-error learning. The general rule seems to be that when a new disturbance is encountered, the worker sets about to acquire by trial and error an adaptive reaction to it and often succeeds in so doing without appreciable deterioration of his output during the process.

Influence of Time, Place and Other Habits.—The studies cited above show that the organism has remarkable power of adapting itself to unusual physical conditions of temperature, light, distractions and the like. Although it is highly useful to know that efficiency may be kept high despite unusual and extreme conditions, it does not follow that it is desirable completely to disregard one's surroundings. Unusual conditions require adaptation and the process of adjustment not only consumes energy but also often results in the loss of time and zeal. When possible, work should be done under the least distracting and annoying conditions. In order to facilitate adjustment to unusual circumstances, habits of beginning work at a given time and in a particular place, and of continuing it for a definite period should be carefully exercised. The urge of regular habits will then assist us greatly to overcome the disturbing effects of minor variations in the environment.

The Influence of Drugs

Among adults, a favorite method of relieving boredom or sluggishness and of increasing interest and efficiency is to use drugs. With the increasing tendency of youths to manage themselves, there is the possibility that younger persons will adopt similar expedients. Among drugs are of course included the active principles of tea, coffee, alcoholic and other beverages as well as tobacco. Some of these beverages are given to quite young children in many homes. We shall, therefore, give the gist of available evidence concerning the immediate effects of some of the more popular drugs. Most of the experiments have been performed upon adult subjects. The influences found may be expected to be greater in the case of children since, even if they were equal otherwise, children are smaller than adults. Other things being equal, the effect of a drug varies inversely with bodily weight.

Caffeine.—Caffeine is the active drug in tea, coffee and many soda-fountain drinks. An average cup of hot black tea contains 1.5 grains; an after-dinner coffee about the same; an average glass of cold green tea about 2.0 grains; and a large cup of coffee about 2.5 grains.

Employing a squad of sixteen subjects whose food, sleep, rest and work were controlled during an experiment which extended over forty days, the influence of doses of caffeine ranging from two to six grains upon various mental and motor functions was measured (Hollingworth). Effort to work was insured by prizes, display of rewards and other incentives. The effects of suggestion and anticipation were eliminated by administering the drug in disguise. At uniform intervals the subjects were given a mixture which sometimes contained and at other times did not contain the caffeine.

The effect of a dose of caffeine appears usually within an hour and lasts for several hours, depending on the size of the dose. This substance usually produces a decrease in muscular steadiness and tremors which appear more quickly and last longer with larger doses. In typewriting, greater accuracy results from using the drug, while speed is also increased except by large doses which reduce the rate of writing. In more purely mental work —naming the opposites of words, naming colors, adding, etc.—efficiency was increased by doses of all sizes for periods varying from three to seven hours. In the task of crossing out certain numbers from rows of mixed numbers doses of four grains or more produced improvement in ability which sometimes persisted for nearly twenty-four hours. The stimulating effect of the drug was indicated by the fact that a dose of six grains disturbed the sleep of most subjects and on some much smaller doses had a similar effect. The stimulating influence of caffeine, contrary to general opinion, is not followed by a subsequent period of depression at least not within seventy-two hours.

It should be understood that tea, coffee and other caffeinic beverages contain other substances which may enhance or neutralize the effects of caffeine or produce still other effects, good or bad. What influence the long-continued use of this drug may have on the organism is not known although it is certain that continuous use overstimulates some people to an unfavorable degree.

Tobacco Smoking.—To determine the effects of tobacco smoking upon efficiency or improvement during mental work is exceedingly difficult. Statistics gathered concerning groups of smokers and nonsmokers are interesting but worthless since the groups may differ in many other habits as well as in the use of tobacco. If habitual smokers are used as subjects, the mere deprivation of the exercise of the habit may disturb their attitude toward work. If subjects unaccustomed to smoking are used, the effects of tobacco will not be typical of the effects on the average smoker. If we are interested in the effect of tobacco alone, it is essential that the subject should not know when he is really smoking tobacco and when he is not, since the mere idea of smoking, the pleasure (or displeasure in the case of the unhabituated) or the stimulation provided by the sight, taste and smell, may produce the result rather than the drug itself.

By means of an ingenious pipe, heated by an electric coil, it has apparently been possible to deceive the smoker (Hull). When blindfolded, the subjects were unable to tell whether they were really smoking tobacco or the slightly moistened warm air through the control pipe. Eighteen students, nine habitual and nine nonsmokers, were tested in a number of functions on each of eighteen days. Each day the subject took the series of twelve tests, and then began to smoke, on some days a pipe filled with real tobacco, on others the fake pipe. After beginning to smoke, the subject went through the series of tests three more times, with brief intervals between. The results of this study show that the influence of tobacco smoking is a rather variable matter. With some the immediate effects are detrimental but after an hour or so of continuous smoking they pass off, leaving the performance uninfluenced, or, slightly improved. With others the immediate effect may be beneficial while continued smoking brings on unfavorable effects. On the whole, the tobacco seemed to slow down and disturb the mental abilities involved in learning new material; but tended to improve performance in habitual mental work, such as easy arithmetical computations. The effects were somewhat more pronounced and more unfavorable in the case of the nonhabitual smokers. No individual was always unfavorably influenced in all of the tests, however. There was only a *tendency* for tobacco to exert a detrimental influence more frequently than a favorable influence. Tobacco smoke rather uniformly accelerated the heartbeat and reduced steadiness of motor control; these were the most consistent and pronounced effects. Long and excessive smoking apparently does not produce immunity to these effects.

Concerning the effects of tobacco on general health, ambitiousness, creative inspiration and the like, there are opinions in abundance, but no reliable data.

Alcohol.—The influence of alcohol, administered in its pure form, diluted with water or beverages, upon efficiency in various mental and motor functions has been investigated on several occasions with results which agree in the main. An English psychologist, Rivers, was the first to disguise the alcohol property so that the subject was unable to tell by look, taste or smell, whether the mixture contained alcohol or another harmless substance. This investigator employed tests mainly of muscular efficiency, strength and endurance, upon which little effect was produced except by large doses of alcohol. Effects found in earlier investigations were attributed to sensory stimulation (tastes, odors, sting) or to expectation of improvement rather than to the drug itself.

The influence of alcohol on both motor and mental functions has been recently investigated (Hollingworth). The alcohol dosage was administered in the form of beer which was 2.75 per cent alcohol by weight. Six trials of each test were given during the forenoon. At noon the beer was given with a small amount of food. On certain days beer was given which was identical in all respects with the genuine except that the alcohol had been removed, thus providing a control. During the afternoon, six trials of each test were given again. In the accompanying table, the gains and losses of efficiency due specifically to alcohol are given in terms of percentages.

DECREASES IN EFFICIENCY IN VARIOUS FUNCTIONS PRODUCED BY

	BEER CONTAINING TOTAL OF 40–50 CC. ALCOHOL	BEER CONTAINING TOTAL OF 66–67 CC. ALCOHOL
Steadiness	68 per cent	241 per cent
Tapping	7 " "	13 " "
Coördination	6 " "	10 " "
Color naming	2 " "	7 " "
Opposites	5 " "	12 " "
Adding	10 " "	15 " "
Gain in pulse rate	8 per cent	10 per cent

The loss of efficiency due to alcohol is universal and pronounced among the functions tested, with the exception of the rise in pulse rate. Coördination of motor control and speed of tapping are appreciably reduced, steadiness is more markedly disturbed. For all of these motor functions, the effect of the large dose is greater than that of the small. On mental efficiency, the drug has a similar disastrous effect, similarly proportionate to the size of the dose.

The singular rise in pulse rate, which was also observed by Hull to result from the use of tobacco, is probably a symptom of the arousal of internal mechanisms to combat the damaging effects of the drug. In support of this hypothesis was the finding by Hollingworth, that those subjects whose mental and motor control were least influenced by the drug showed the greatest increase in pulse rate.

Other Drugs.—*Strychnine* in fairly large doses (1/15 to 3/15 grains) seems to lead to a temporary increase in ability to run a complex machine (dotting machine) and in capacity to memorize, often followed by a decrease to less than normal capacity unless the dose is repeated. Very small doses, 1/30 to 1/20 grain (according to Poffenberger), produce negligible results on speed of tapping, aiming and a wide variety of mental functions. *Opium* and *morphine* appear to cause an initial stimulation which appears slowly and rises to a maximum, and then efficiency descends below, sometimes considerably below, normal. *Cocaine* causes a large immediate stimulation followed by a period of pronounced depression. Because of its immediately stimulating effects it has become a great favorite among drug addicts.

CONCLUSIONS

The experiments here given disclose only the immediate effects of external conditions, work and drugs upon interest and efficiency. It would be unsafe to conclude that influences showing great immediate effects upon mental efficiency and skill would have a correspondingly serious effect upon general health or upon particular bodily functions and organs when used continuously. It would be likewise unsafe to conclude that influences whose immediate effects are slight or zero would produce, when continuously used, no general or specific ill results. To determine the outcome of the habitual use of drugs or of habitual exposure to unusual environmental conditions constitutes another and more difficult problem. Of no mean importance, however, is the finding that not unusual doses of alcohol, caffeine, strychnine and other drugs disturb mental and motor efficiency at once and more profoundly than deprivations of food or sleep, or exposure to natural extremes of atmospheric conditions, or to visual and auditory distractions, or continuous mental work. These substances richly deserve their name—"powerful drugs."

In the course of normal life, efficiency in mental work fluctuates not mainly because of the intrinsic effects of tea, wine, tobacco, fatigue, noise or bodily conditions, but because of variations in motivation, interest and the drive of habit. The depressing effects of tobacco or moderate doses of alcohol are small compared to decreases in efficiency produced by relaxation of effort; the stimulating effects of brilliant light or coffee are slight compared to the increase in achievement resulting from effective incentives. By dint of strong urges to succeed, the effects of excessive fatigue, loss of sleep, deprivation of food and bodily discomfort upon mental efficiency, may be almost, if not wholly, swept aside. It does not follow that such practices should be followed without good cause. Excessive effort in such emergencies doubtless activates the sympathetic system and internal glands described in previous chapters. In the long run, keeping productivity at the maximum under unfavorable conditions may lead to disastrous results. That few conditions, with the exception of certain drugs, can keep us from rising to maximum achievements, at least temporarily when we will, is a notable possibility that need not be misused. Equally notable is the fact that, apparently, in normal daily life our productivity is appreciably less than it might be; it may be greatly increased not so much by "will power," and not so safely by drugs, as by well formed working habits, abiding interests and sanely managed incentives. What is more important it may be brought to higher levels and there habituated by well motivated and wisely directed practice, eventually to work as smoothly and with as little effort as at levels which are mediocre.

QUESTIONS AND EXERCISES

1. According to the author, what is interest?

2. Enumerate some of the things you would do as a teacher to increase the pupils' interest in reading or geography.

3. Can you give an illustration of how difficulty in "warming up" to a task was overcome?

4. Arguing from analogy with facts presented in the chapter, what are the probable effects upon mental efficiency of: (a) headache, (b) "feeling out of sorts," (c) despondency, (d) indigestion, (e) toothache? Would the effects of these conditions vary with the effort one makes to work or would they have the same effect whether one tries to achieve or not?

5. If too much zeal, effort or distraction results in activating the autonomic system, would continuous work under such conditions be advisable? Explain.

6. Are there any dangers to be encountered in the continual use of incentives, such as those mentioned in Chapter V, as a means of increasing proficiency?

7. What, in general, is the best state of mind for efficient daily work? (Glance over the discussion of emotions again.)

8. From the studies of variations in efficiency during the day, what hours are probably the best for important tests in typewriting, playing the piano, pole vaulting, history, sending telegraph messages?

9. Explain the assumption that in the case of the habitual smoker, deprivation of smoking might have, irrespective of the physiological effect of the drug, a deleterious influence on efficiency.

10. Judging from statements made in the text, is it likely that we are very good judges of when we are highly efficient and when we are not? Mainly, what are the criteria by means of which we judge our efficiency?

11. Collect the opinions of ten people of your acquaintance concerning the effect of caffeine on efficiency. What reasons do they give

for their views? Contrast such evidence with the conclusions drawn from scientific experimentation.

12. What are the real reasons why good ventilation is important? The false reasons?

13. Give illustration from your own experience of (a) a situation where feelings of fatigue preceded the loss of efficiency; (b) a situation where loss of efficiency preceded feelings of fatigue; (c) a situation where the decrease of worry and excitement increased mental ability; (d) a situation where the elimination of unnecessary muscular fatigue made an increased amount of mental work possible.

14. At what time of the day do you think you can perform mental work most efficiently? Plan in detail an experiment to test this opinion. What precautions would it be necessary to observe?

15. Do the experiments on temperature and humidity have any bearing on the problem of the differences found between races living near the equator and races living nearer to the poles?

16. Make a careful study of your working habits. Draw up a plan for improvement.

17. Why should particular tasks be connected in thought with one's fundamental purposes?

18. What are the relations between interest and efficiency? Between interest and effort?

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CHAPTER XV

INDIVIDUAL DIFFERENCES IN INTELLIGENCE

This chapter will be primarily concerned with the measurement, the nature and the educational significance of intelligence. Many facts presented in preceding chapters form an introduction to these topics. Since intelligence shows itself in nearly all forms of learning, perceiving, reasoning and imagining, the facts presented in treating these topics are closely related to the present one. In the discussion of the transfer of training, we observed that able students profited far more in a general way from studying any school subject than did the less able ones. Since we shall be interested in discovering whether intelligence is native or acquired, we shall be assisted by the various facts concerning the influence of heredity and environment offered in several earlier chapters. Since our concern with the nature and significance of intelligence is tied up with the problem of individual differences in this trait, we must present certain facts concerning the degree and character of individual variations as a final step in introducing this topic.

The Amount and Character of Individual Differences

Individuals Differ in All Measurable Traits.—Individuals of the same age differ greatly in every trait that has been measured or estimated. In height, weight and strength; in susceptibility to disease; in nervous stability and mental balance; in spelling, arithmetic, music, athletics, carpentry and other forms of acquired knowledge or skill; in intellect, emotionality, temperament and morals, individual variations are found. We do not know of any trait of body or mind in which individuals do not differ.

Individual Differences Are Quantitative, Not Qualitative.—The differences between members of the human species are quantitative. People are qualitatively the same in the sense that they have in some degree the same instincts, emotions and capacities to learn, to perceive, remember, imagine, reason and to be satisfied and annoyed. The physicists who have analyzed the "qualities" of tones of the human voice, of the violin, and of other instruments, find that the most subtle variations are due to the quantities of many constituent tonal elements which have been identified and measured. So with human traits, final analysis will probably show all variations to be due to quantitative combinations of specific abilities, which sooner or later may be discerned and measured. A human trait, such as initiative, vivacity or trustworthiness is, in the case of each individual, a composite of many kinds of abilities or tendencies each present in a definite amount.

Variations among Individuals Are Wide.—That variations among individuals are wide in acquired information and skill may be easily shown by giving a series of tests to a group of children of the same age selected at random. The following table is a sample of the differences between the extremes:

Average of the Two Best and Two Poorest Scores Found among 50 Children, Age 11, Approximately, in a New York School

	Best	Poorest
Reading, words per minute	242	126
Reading, value of hardest passage comprehended	30	12
Word knowledge, score	80	32
Spelling, number of words correct	95	33
Arithmetic, number of problems right	26	11
Writing, letters per minute	84	31

The most rapid readers cover nearly twice as much material per minute as the slowest; the best in word knowledge attain scores over twice as high as the poorest; the best in spelling correctly spell three times as many words as the poorest, and similar differences exist between the extremes in other abilities. The variations among the pupils in the same school grade in the average school are nearly as great.

Variations Show a Continuous, Typical Distribution.—These are merely statements of the differences between the best and poorest. The nature of individual differences in general are disclosed only by taking into account all the members of a group. This may be done most conveniently by means of a graphic device called a *frequency surface*, such as the one shown in Figure 36. Figure 37 shows a frequency surface based on a larger number of individuals (254 children) in a battery of educational

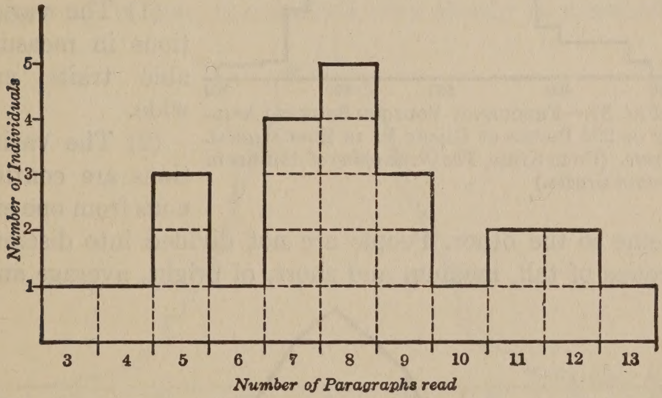


FIG. 36.—A FREQUENCY POLYGON BASED ON RESULTS OF A READING TEST. The horizontal line shows the scores in the test; the vertical column at the left gives the number of individuals, *i.e.*, the frequency. Each individual is represented by a block. Usually the dotted lines are omitted since the number of individuals in the column above each score can be easily determined by a glance at the figures on the left.

tests; Figure 38, a still larger group (1052 women) in a physical trait, height, and Figure 39 for a still larger number (1656 pupils in Grade 9) in a complex of mental abilities.

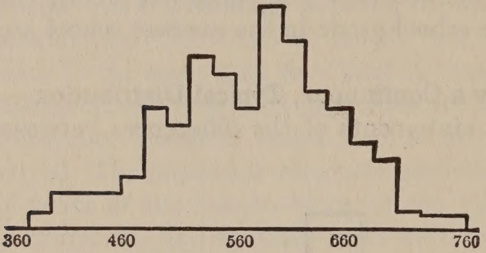


FIG. 37.—FREQUENCY POLYGON SHOWING ABILITY OF 254 PUPILS OF GRADE VI IN EDUCATIONAL TESTS. (From Kruse, *The Overlapping of Abilities in Certain Grades.*)

All of these surfaces show the same general facts, namely, that among individuals of the same age or school status:

(1) The variations in measurable traits are wide.

(2) The variations are continuous from one extreme to the other. People are not divided into discrete groups of tall, medium and short, of bright, average and dull, but form an unbroken series from one extreme to the other.

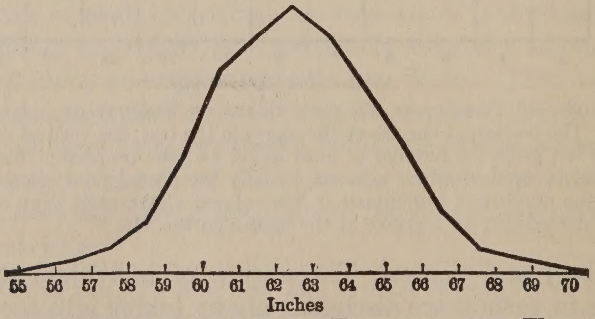


FIG. 38.—DISTRIBUTION OF THE HEIGHTS OF 1052 WOMEN. (From Starch, *Educational Psychology.*)

(3) The variations assume a typical form, which re-

veals the individuals clustered around a central or average ability and thinning off toward each extreme. The most numerous individuals are those possessing average ability and as ability becomes greater or less, the number of individuals becomes smaller.

The Normal Curve of Distribution.—It may be noted that the frequency surfaces (Figures 36 to 39) become more regular and symmetrical as the number of individuals represented becomes greater. The solid line surface in Figure 39, in fact, corresponds very closely to a smooth curve represented by the broken line in the same figure. Now, this broken line describes a figure which all frequency surfaces approach gradually, as the number of persons measured becomes greater. It is assumed that, were several million properly selected persons tested, the frequency surface would be much closer to this smooth figure than it is in Figure 66. For this reason it is assumed, unless definite knowledge to the contrary is at hand, that individuals in general are distributed in any trait in approxi-

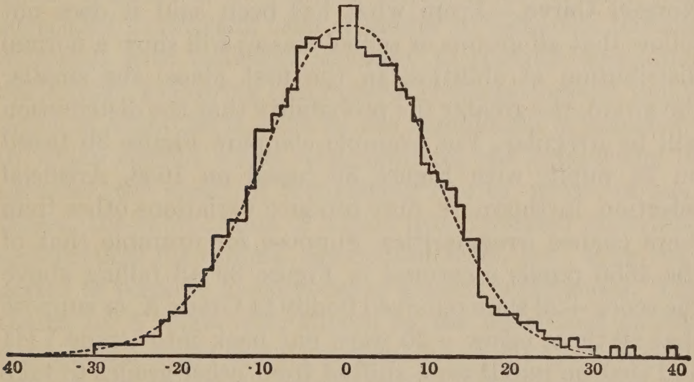


FIG. 39.—DISTRIBUTION OF SCORES IN A TEST OF MENTAL ABILITIES OF 1656 PUPILS IN GRADE IX. The broken line is the theoretical probability curve. It fits the real distribution fairly closely. (From E. L. Thorndike, *Journal of Educational Research*, Nov., 1924.)

mately the manner outlined by this figure, which is referred to as the *Normal Curve of Distribution, Normal Frequency Surface, Normal Probability Surface* and in other ways. Whenever we do not know the form in which a human trait which we cannot yet measure definitely—sympathy or modesty, for example—is distributed, we usually assume that it will approximate this ideal, Normal Surface, more closely than any other. This would be a guess, but the best guess one could make.

Artificial Selections May Produce Deviations from the Normal Curve.—From what has been said it does not follow that all groups or school classes will show a normal distribution of abilities. In the first place, the smaller the group, the greater the probability that the distribution will be irregular. For example compare Figure 36 based on 24 pupils with Figure 39 based on 1656. Artificial selection, furthermore, may produce variations other than mere chance irregularities. Suppose for example that of the 1656 pupils measured in Figure 39 all falling above the score +20 were removed bodily to Grade X, or suppose that all those below −20 were put back into Grade VIII and that no pupils were shifted from other grades to take their places. These changes would result in departures from the Normal Curve. In actual practice at the present time such shifts tend to be compensated for by shifts from other grades so that in the long run not only groups of the same age but also pupils of the same grade tend to show distributions of ability closely approximating the Normal Curve as shown in Figure 39.

Now, as a matter of fact, the distribution surface shown in Figure 39 is based upon a series of tests that indicates quite closely the nature of individual differences in intelligence. The variations are wide and continuous. With this important fact in mind, we are ready to consider what intelligence is, how it is measured and what uses may be made of the measurements.

Typical Tests of Intelligence

Early Conceptions of Intelligence.—The fact that individuals differ in ability to learn, to adjust to novel situations and to manage things, people and ideas, has been repeatedly observed throughout the course of recorded history. In the early stages of experimental psychology, efforts were made to measure more precisely some of the aspects of intelligence. In 1880, Ebbinghaus first succeeded in devising tests of ability to memorize various materials with sufficient accuracy to portray individual variations. Following this notable accomplishment, many types of single tests, such as the completion of sentences in which certain words were omitted, the completion of pictures, the speed of recognizing figures, words or sentences, the cancellation of letters from specified materials, arithmetical operations, association tests, etc., were suggested as possible touchstones of general intelligence. The search for a single test, guided by the belief that intelligence was a single unitary power that might disclose itself in clean-cut fashion in a single task or situation, inevitably led to but partial success.

Binet's Conception.—It remained for Alfred Binet, a distinguished French psychologist, to conceive the idea that intelligence was not a single quality or power, but a complex of abilities. The effect of this belief was a radical change in the method of approach to the problem. Conceiving intelligence to be not homogeneous but possessing many aspects, Binet began a search for many types of performances or problems in which intelligent behavior should be displayed. Believing also that intelligence was largely native, although recognizing the fact that previous experience influences the results of most psychological tests, Binet began by searching for bits of information available to children in all walks of life, and for problems, puzzles, questions, mental tasks of various types that were not likely to be encountered under ordinary home or school conditions. The information sought, then, was of the sort that every child has ample opportunity to acquire, and the problems of a type that no child was likely to have previously learned to solve.

The Binet-Simon Tests.—After fifteen years of work, in part of which he was assisted by Theodore Simon, Binet published in 1908 the series of tests known as the *Binet-Simon Scale of Intelligence.* Stimulated by this successful achievement, a large number of extensions and revisions of the scale have been made in many countries. In America the work has been specially active, and among the several revisions, that by Terman, known as the *Stanford Revision and Extension of the Binet-Simon Scale,* is most thorough. This scale consists of ninety tests arranged, like the original, in order of difficulty from some that should be passed by a three-year-old child to others that demand "superior adult" ability.

What the scale actually measures may be explained more readily after an examination of some of the tests. In the group for age three are the following tasks:

Points to the nose, eyes, mouth, hair. To pass the test, the child must succeed in 3 of the 4 tasks.

Names familiar objects—key, penny, closed knife, watch, pencil. Subject must succeed in 3 of the 5 tests.

Enumerates at least 3 objects seen in 1 of 3 pictures displayed separately.

Gives sex, *i.e.*, boy or girl.

Gives last name.

Repeats sentence containing 6 or 7 syllables; *e.g.*, "The dog runs after the cat."

Repeats 3 digits, one success in 3 trials.

In the group for age ten are the following:

Defines satisfactorily at least 30 words of a list of 100, ranged in order from easy to difficult. Words at about the 10-year level of difficulty are: lecture, dungeon, majesty, treasurer, reception. The hardest words in the list, which are mainly too difficult for the average adult, are: piscatorial, sudorific, parterre, shagreen and complot.

Detects the "absurdity" in 4 out of 5 statements such as the following: "A man said: 'I know a road from my house to the city which is downhill all the way to the city and downhill all the way back home.' "

Copies from memory a geometrical figure previously studied for 10 seconds.

Gives satisfactory answers to 2 out of 3 questions such as the following: "What ought you to say when some one asks your opinion about a person you don't know very well?"

Must be able to say spontaneously at least 60 words—any words of which the subject can think—in a period of 3 minutes.

Other Tests of Intelligence.—The Binet Scale is an instrument of precision, carefully standardized, which must be given to subjects individually by trained examiners. To meet the demands for more extensive testing, various forms of "Group Tests" which may be administered by competent people without extensive training have been devised. These tests were developed along lines similar to those adopted by Binet.

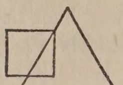
Group Tests.—Group tests may be divided roughly into two types, the *verbal* and the *nonverbal*, although many include both types of material. Of the verbal tests, the most familiar is the "Army Alpha," devised by a group of American psychologists and applied to more than a million and a half men in the American Army during the Great War.

The Army Alpha test, given to recruits who could read and write, consists of 212 separate questions, exercises or problems of eight general types, of which four are here illustrated.

The first group of tests comprised twelve tasks ranging from easy to hard, of the following type:

The examiner says: "Attention. Look at the square and triangle at 3. When I say 'Go,' make a cross in the space which is in the triangle but not in the square, and also make a figure 1 in the space which is in the triangle and in the square.—'Go!'" (Allow not over ten seconds.)

3.



Test two consists of twenty arithmetic problems.

Test three consists of sixteen "common-sense" problems. The subject is to make the best answer. The easiest and most difficult are: (1) Cats are useful animals because—they catch mice; they are gentle; they are afraid of dogs. (16) Why is it colder nearer the poles than at the equator? Because—the poles are always farther from the sun; the sunshine falls obliquely at the poles; there is more ice at the poles.

Test four consists of forty pairs of words, the two words of each pair being either synonyms or antonyms. The examinee is to underline *same* or *opposite* where appropriate. The first and last pairs are:

Wet—dry.............................same—opposite
Encomium—eulogy...................same—opposite

There are many other verbal group tests, some especially designed for elementary schools, some for high schools, some for colleges and others for use among clerical and other occupational groups. Nonverbal group examinations have been devised to test very young children, illiterates and others who cannot read or write words. In some of these examinations directions are conveyed orally; in others by means of pantomime.

Performance Tests—Various performance tests which use "form boards" into which figure and picture cut outs are to be fitted and other such materials instead of pencil and paper have been designed for very young, deaf and variously handicapped children and adults. In nearly all types, the tests follow Binet in arranging a variety of problems and a range in difficulty from easy to hard.

The various types of tests and scales are not exactly equivalent. They do not all measure identical abilities, although there is much in common among them. It will be advisable, therefore, to confine the discussion mainly to one test, the Stanford-Binet. But before attempting to tell what intelligence is, we should understand how the results of intelligence tests are expressed and what some of the assumptions are which underlie these expressions.

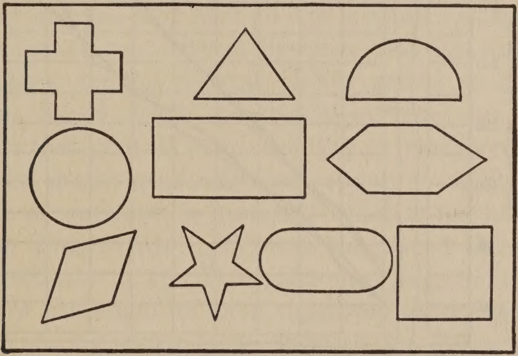


FIG. 40.—THE SEQUIN-GODDARD FORM BOARD, ONE OF THE EASIEST, USED WITH CHILDREN OR FEEBLE-MINDED ADULTS. Blocks to fit the holes shown in the above board, are placed before the subject in a prescribed arrangement. The score is based upon the time required and number of errors made in fitting the blocks into the holes.

MENTAL AGE AND INTELLIGENCE QUOTIENT

The Mental Age.—To make the subject's score on an intelligence test meaningful, a standard of comparison must be provided. The method adopted by Binet, and by many others later, was to use the average performances of individuals of different ages as a standard of comparison. Binet ascertained just what the average score achieved by a representative group of three-year-old children, four-year-old, etc., was. It was then possible to state a child's achievement in terms of the age at which the child of average ability would secure the same score. This score is called the "Mental Age" or the "M.A." for short. Thus, a particular child whose achievement in the test is equivalent to the Mental Age of ten years has

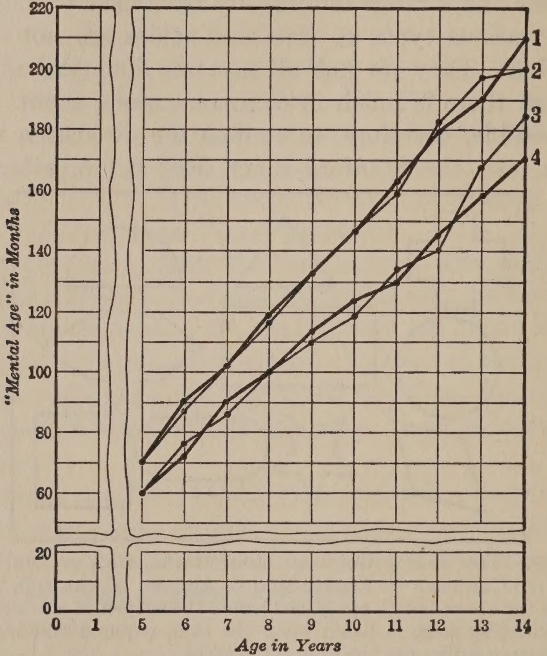


FIG. 41.—ACTUAL MENTAL GROWTH CURVES FOR FOUR GROUPS OF CHILDREN OBTAINED BY CONSECUTIVE ANNUAL MEASUREMENTS WITH THE STANFORD-BINET SCALE. Number 1 is a curve for bright boys; 2 for bright girls; 3 for less bright girls and 4 for less bright boys. If the lines were straight, a constant I.Q. would be indicated. (From Baldwin and Stecher, *University of Iowa Studies*, Vol. II, No. 1.)

the general mental ability of the average ten-year-old; it matters not what the actual chronological age of the particular child may be.

The Mental Age, then, gives us a statement of the general mental ability of a subject as measured by this test *at the time the test was given*, in comparison with average children of different ages. If a ten-year-old child earns an M.A. of ten, he has *average* mental ability. If he earns an M.A. of eleven years he is obviously superior to the average; if he earns an M.A. of eight years, he is markedly inferior. The Mental Age is really a statement of a child's mental maturity at the time, and this implies, of course, that general mental ability grows or matures. There is, indeed, fairly substantial evidence for this assumption that general mental ability as measured by the Binet test grows gradually and about as uniformly as height to a maximum or maturity which is reached about the same time, or later. Terman has placed the average age of maturity at 16; Thorndike (see page 97) at about 22. Other investigators have suggested other ages. The age of maturity seems to be different for different tests. Individuals, moreover, mature at different times mentally as they do physically.

The Intelligence Quotient.—For practical purposes, we want to know more than merely the amount of general mental ability at the moment; we wish to know, if possible, how rapidly the child's mental ability will develop. We desire to be able to predict growth in mental ability; to tell what it will be one, two or more years hence. The device most commonly used for this purpose is the Intelligence Quotient, or the "I.Q." The Intelligence Quotient is obtained by dividing by the Chronological Age the Mental Age received on a test like the Stanford-Binet. For example: Pupil A has an M.A. of 10 years and a

Chronological Age of 10 years. Divide M.A. 10 by C. A. 10, the Intelligence Quotient is 1.00; Pupil B, whose Chronological Age is also 10, has an M.A. of 12; 12 divided by 10 gives an I.Q. of 1.20. Pupil C, also 10 years of age, earns an M.A. of 8, which divided by 10, gives an I.Q. of .80. Usually the decimal is disregarded; we say that A has an I.Q. of 100, B of 120 and C of 80. The Intelligence Quotient is obviously a ratio—the ratio of the Mental Age to the Chronological Age.

The usefulness of the Intelligence Quotient depends upon an assumption, namely, that it will remain fairly constant from year to year under ordinary conditions of life. If the I.Q. should remain constant, or nearly so, under normal conditions, it would be useful in two ways. It would indicate the rate of mental growth in the future and express a person's relative mentality or brightness. An I.Q. of 100 would mean that the child probably has grown, is now growing and will continue to grow in mental ability at the average rate. An I.Q. of 120 would mean a growth 20 per cent more rapid; an I.Q. of 75 would mean a growth 25 per cent less rapid than the average. If the I.Q. remained approximately constant from year to year, it would express the relative brightness or dullness of an individual. Thus, irrespective of age, an I.Q. of 100 would mean average mental alertness, suppleness,—or whatever mentality is—whereas a higher I.Q. would indicate superiority in these respects and a lower I.Q. inferiority.

PRELIMINARY DEFINITION OF INTELLIGENCE

Now that we have seen samples of the tasks presented in the Binet and other tests, and have observed certain facts concerning the scores obtained from such tests, it is time to inquire what these tests actually measure and what intelligence is. First, let us see what the makers of tests were *trying* to measure. We can get some idea by studying the test elements themselves.

Among the ninety tests in the Stanford Revision of the Scale are many which measure the ability to manipulate mentally, familiar facts, such as repeating digits forwards and backwards, counting backwards, visualizing changes of the hands of the clock; to reason out the solution of problems which utilize the facts of arithmetic, of physical relations and of practical situations. In some tests, the knowledge of abstract facts and relations is demanded: *e.g.*, in defining such words as pity, revenge, charity, envy; in giving the similarities in three things, such as wool, cotton, leather; the differences between a President and a King or between poverty and misery; in grasping the thought contained in a short paragraph, or in giving the meaning of pictures or fables. In general, the Binet test seems to include a variety of tasks on which the mental abilities described in our previous chapters on learning, the acquisition of ideas, especially abstract ideas and reasoning or problem solving, depend. Indeed, these were precisely the aims of Binet and his followers. They attempted to secure tests of various abilities to learn, especially to learn complicated and abstract facts, and also to profit by experience in a general way. They tried to secure tests that would indicate ability to adapt one's self to new situations, to see the problem, hold it in mind and reason out the solution. In these tasks, it is assumed that mental alertness, keenness, quickness and breadth of grasp, as well as suppleness, accuracy and control would be involved.

It may be said, then, that intelligence was conceived as a composite of abilities to learn, to grasp broad and subtle facts, especially abstract facts, with alertness and accuracy, to exercise mental control and to display flexibility and sagacity in seeking the solution of problems. It may be further stated that these abilities were conceived to be native. This fact is shown by Binet's efforts to secure in his scale the kind of problems that were based upon facts that all children would have ample opportunity to learn under reasonably normal conditions, but problems that no, or few, children would have been trained to solve. By trying to avoid the influence of special home or school training in this way, Binet hoped to reveal native intellectual aptitudes and capacities.

IS INTELLIGENCE NATIVE OR ACQUIRED?

Is intelligence native or acquired? This is a question that has been very hotly debated. For education, it is an issue of such great practical importance that we must endeavor to solve it. In debating this question, the proponents of the two sides—those who maintain that intelligence is native and those who declare it is largely acquired—have often shown extraordinary inability to understand each other. Let us, therefore, present the facts which seem to be most commonly misunderstood.

The main difficulty has been a failure to distinguish between what an intelligence test ovbiously and directly *tests* and what the scores from the test *imply under certain conditions.* Many opponents of the idea that tests of "intelligence" reveal differences in native intellectual capacity, point to the things that the tests require the child to do. Glancing over such problems as those suggested a few pages earlier, they observe that the child is asked to name familiar objects, give his sex or last name, speak words, do arithmetic problems and so on. They then declare: " These are not tests of capacity; they are tests of learning or achievement. They are tests of information, *acquired* knowledge and skill. Surely nothing is more truly and fully the product of learning than giving your name or doing problems in arithmetic or accomplishing other tasks set up in these tests. That these tests measure accomplishment or acquired ability and not innate capacity is as obvious as the light of the sun."

Now, it is true that intelligence tests do directly measure what one has learned. This fact *is* as obvious as the light of the sun. Intelligence tests are just as much tests of learning or achievement as are tests of reading or spelling or history. How does it happen, then, that these tests are called *intelligence* tests? If they measure acquired abilities, how can they also measure native intellectual capacity? If all of the many achievement tests now in use measure the products of learning, why are some singled out as tests of intelligence?

Here is the answer to these questions. *Any test of acquired ability can and does reveal differences in native, constitutional capacity among those persons of the same age whose experiences have been equally potent in so far as they affect the ability to do the exercises in that test.*

The facts underlying this statement are as follows: First, many hundreds of studies have shown that when all educative influences upon a given ability are absolutely the same for a number of persons of a given age, a test of these persons will reveal wide differences in *ability*. If educative influences for a group of children, of a given age, are the same, the wide variations in ability must be explained. They cannot be explained as due to differences in education, experience, opportunity or environment because, by definition, all educative factors are equal. The differences in ability must then be explained as due to some other factors—as due to mysteries, spirits, demons or something else. The second fact is that science has found it practically useful to assume that these differences in ability which appear when environmental influences are identical, are not due to occult powers but to native, constitutional factors or *capacities*. These are the reasons for saying, to repeat the statement in different words, that: *When, for a group of persons of the same age, environmental influences affect equally the scores on any test, the scores on that test then measure native constitutional factors or innate capacities.* This is the theory underlying the measurement of native intellectual capacities. It is, the author believes, a sound theory.

The endeavors to measure a rather broad form of native, intellectual capacity which is commonly termed *intelligence* have been efforts to find tests of a complex of mental abilities upon achievement in which ordinary *variations* in environment, education and experience have little or no influence. The intelligence tests, in other words, are not measures of constitutional capacity because they test abilities that are instinctive or unlearned, but because they test abilities that all, or nearly all, children living in ordinary circumstances have had substantially equal opportunity to learn. The Binet-Simon is a good test of native capacity merely because, with few exceptions, children of a given age have about equally good preparation for that test despite innumerable variations in their *particular* home and school experience and training. Many tests are not good, because the experiences of some children in a typical community give them an advantage over other children.

Theoretically, intelligence is conceived as a complex of native, constitutional capacities. Practically, it is important to discover, first, how accurately *tests* of intelligence now available reveal these native differences. The most crucial test of the tests is the degree to which scores vary when variations from typical surroundings, education and experiences are put into effect. Since the facts vary from test to test, we shall consider only the Binet-Simon type.

Consistency of the Binet-Simon I.Q.—In the case of the Binet-Simon scale, the value and validity of the test, as a means of measuring native intellectual capacity, is indicated by the changes in the I.Q. which variations from the typical educational and environmental influences bring about. That the Binet-Simon test does yield an indication of native intelligence valid enough and often enough to make it an extremely useful instrument, has been indicated by scores of studies. The crucial outcome of these studies is the fact that the I.Q. tends to remain constant. Once a low I.Q. always a low I.Q.; once an average I.Q., always an average I.Q.; once a high I.Q., always a high I.Q., is the general tendency. This is the general rule, to which there are occasional exceptions. Minor changes in I.Q. are frequent; large ones are rare when the examination is conducted by an expert. Despite these changes, the I.Q.'s actually obtained from the Binet-Simon tests show a tendency to remain constant. This tendency justifies the statement that, when sensible allowances are made for the defects in the test, the evidence indicates that with rare exceptions a person's native intellectual aptitude as shown by the I.Q. tends to remain throughout life at a level which is relatively low, average or high.

Causes of Variations in I.Q. as Measured by Available Tests.—It should be understood that the tests of intelligence are not yet perfect and that many testers are less so. For this reason alone, consecutive measurements of children at intervals of a year or so show some fluctuations in I.Q. Figure 41 gives curves based on consecutive measurements. Changes of two to five points, up and down, are common, larger changes occur less frequently. The average shift is probably less than five points. These changes are due partly to defects in the tests and to errors in the testing. However, it has been shown that radical changes in environment and education may also produce a change in I.Q. at least temporarily. This is especially true of intensive training of children previously neglected. It was found for example (by Freeman and Terman) that young children transferred from poor to superior homes, when adopted by foster parents, are likely to gain somewhat in I.Q. The averages of the gains after four years of life in the superior homes have been variously estimated from 2 to 6 points, I.Q. As yet there is no evidence that these gains would continue indefinitely. These and other studies of the constancy of the I.Q. under various conditions lead us to conclude that while no intelligence test is yet perfect, several are valid enough, when placed in competent hands, to be extremely useful in education as a means of estimating native, constitutional, intellectual capacities. Let us next consider more carefully what the significance of intelligence is and what practical uses may be made of the tests.

THE RANGE OF INDIVIDUAL DIFFERENCES IN INTELLIGENCE

Before taking up the significance and uses of measures of intelligence, we should show the character of individual differences in terms of the measures obtained from the Binet tests. The most convenient way is to show the distribution of I.Q.'s obtained on the Stanford Scale, the most widely used revision of these tests.

The polygon, in Figure 42, shows the distribution of I.Q.'s found among 905 children selected at random by Terman. Generalizing from such data as these, it is estimated that the distribution of intelligence in the population at large is about that given in the following table:

I.Q. below 70	1%
I.Q. 70–79	5%
I.Q. 80–89	14%
I.Q. 90–99	30%
I.Q. 100–109	30%
I.Q. 110–119	14%
I.Q. 120–129	5%
I.Q. over 130	1%

Keeping in mind our provisional definition of intelligence as a composite measure of capacities to learn, to grasp broad and subtle facts with alertness and accuracy, to generalize and display sagacity in reasoning and problem-solving, we may now seek to determine more exactly the relation of intelligence and various forms of achievement.

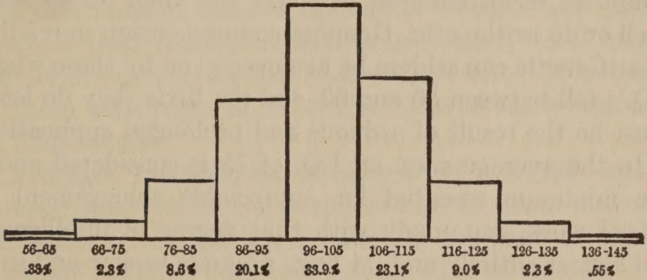


FIG. 42.—DISTRIBUTION OF THE I.Q.'S OF 905 CHILDREN. The height of each rectangle indicates the number of children having I.Q.'s within the range designated by the first line of figures under the graph. The second line gives the exact percentage of the whole number of cases (905) in each subgroup. (From L. M. Terman, *The Measurement of Intelligence*, by permission of Houghton Mifflin Company.)

INTELLIGENCE AND SCHOLASTIC ACHIEVEMENT

Inferior Intelligence.—Intelligence Quotients of 20 or less are found infrequently. Persons with I.Q.'s in this range are "idiots," essentially incapable of learning. Individuals with I.Q.'s from 20 or 25 to 50 or so are ordinarily called "imbeciles" and all within this range are capable of but meager learning and adaptability. In the range from 50 to 70 I.Q. are found various degrees of "feeble-mindedness," which grade quite imperceptibly into the less, but nevertheless seriously, dull individuals above. Throughout this enormous range, from approximately 0 to 70 I.Q., there is absolutely no doubt about the innate limitations upon the acquisition of complex mental functions, and the rate of acquisition where learning is possible at all. It is almost invariably futile to attempt to teach children of I.Q.'s less than 50 to read, spell or do arithmetic. Genuine comprehension in reading or arithmetic can seldom be achieved even by those whose I.Q.'s fall between 50 and 60, and the little they do learn must be the result of arduous and prolonged application.

In the average case, an I.Q. of 75 is considered about the minimum essential for appreciable achievement in school work, but many with that degree of intelligence fail almost entirely and, at best, progress is slow and soon halted. The average case can scarcely succeed beyond the fifth grade. In the schools most of the pupils recognized by teachers as "very dull" and "very slow" will be found to have I.Q.'s between 70 and 85. Most of these children are retarded in their school progress. Children with I.Q.'s of 80 to 85 drop out early in considerable numbers, but many struggle along to finish the eighth grade, 1, 2, 3, 4 or more years retarded. It is found that most of those who persist are promoted more rapidly than their achievements warrant, mainly because they are bigger and older.

The average child with an I.Q. of 90 is usually delayed a half or a full year in completing the eight grades. The average child with an I.Q. of 95 is quite likely to finish on time. Burt found that among London children those with I.Q.'s from 85 to 95 are the ones from the whole range of intelligence with which the school achieves the most in proportion to their innate ability. "There is discernible an effort, and an effort by no means sterile, to coax and coach these milder dullards to a grade more closely fitted to their actual age." But Burt, like many others, found that despite coaxing and coaching, these children seldom equal the children of average endowment (*i.e.*, with I.Q. of 100). That they have difficulty in keeping up the pace set by the school is here implied, and that most of them at the end of Grade 8 have about reached their limit is indicated in a study by Proctor, who found that in the first year of high school 70 per cent of those with I.Q.'s of 95 or less failed in more than half of their studies.

Average Intelligence.—Children of average intelligence—those whose I.Q.'s cluster closely about 100—set the pace in the grades. Examining the records of two hundred pupils, whose I.Q.'s range from 95 to 105, Terman found that aside from retardations clearly due to loss of schooling through illness or other causes, nearly all had made regular progress. The range 95 to 105 I.Q. includes about thirty-three per cent of the general population and probably about forty per cent of the population of the elementary schools.

Superior Intelligence.—The total number of children above 105 is about the same as that below 95; namely, about thirty-three per cent. The former exceed the average in intelligence as much as the latter fall short of it. Since the I.Q.'s are really ratios of mental growth, it is held by many that the rate of progress through school should show similar ratios. That is, if the child with an I.Q. of 100 progresses at a given rate, one with an I.Q. of 75 should progress 75 per cent as fast; one with an I.Q. of 125 should progress 25 per cent more rapidly than the average; and so on. But just as the children between 85 and 95 are coaxed and coached along because they need it, and are promoted undeservedly to keep the age group intact, those above 105 are given less attention, because it is seldom needed, and are retained in the group with the same chronological age. Extra promotions of children of 100 to 110 I.Q. are therefore not numerous. The child of 113 should be able, some maintain, to complete eight grades in seven years; 125 I.Q. in six; 138 in five; and 150 in four. That these are entirely justifiable expectations is not as yet clearly demonstrated, although there is no doubt that children of higher I.Q. are scholastically more proficient.

Of fifty-four children between 120 and 140 I.Q.'s studied by Terman, 12½ per cent were advanced in the grades two years; 54 per cent were advanced one year; 28 per cent were making average progress; and 5½ per cent were actually retarded one year. Of a group of forty-seven children with a medium I.Q. of 145, Terman found none retarded; 8.5 per cent at the grade corresponding to their age; 29.8 per cent advanced one year; 29.8 per cent advanced two years; 19.2 per cent three years; and 12.8 per cent four years. This is substantial evidence that the children of better than average I.Q. do exceed the average rate of learning such subjects as taught in school and that, on the whole, the higher the I.Q. the more rapid the progress.

Intelligence and Success in High School.—With regard to the limits of progress in high schools, much depends upon the standards of the school. I.Q.'s of 100 do complete the high schools, but in just what proportions is not known. Among first-year students in Palo Alto High School, the relation between achievement and I.Q. is shown in these figures collected by Proctor and Terman:

1 School Marks	2 Average I.Q.	3 Number of Pupils
50–59	85	12
60–69	100	16
70–79	107	56
80–89	110	24
90–99	123	4

On the average, pupils with higher I.Q.'s earn the higher grades.

Comparison of columns 2 and 3 gives an idea of the personnel of the first-year class in a first-class high school. Approximately two-thirds of the group are 100 or above, half are 105 or above, and a quarter are 117 or above in I.Q. At the end of the first year, of thirteen who dropped out of school, ten were below the median I.Q. (105) and of these, seven had failed in more than half of their subjects.

Intelligence and Success in College.—The minimum I.Q. necessary for successful work in college is not perfectly known. Since none of the Binet revisions contains tests sufficiently difficult to measure high adult intelligence, one must secure data from college students whose I.Q.'s were determined before they reached college age. The records of a sufficient number of such college students are now available to show that in general the higher the I.Q. the better the achievements. It is probable that an I.Q. of at least 110 is needed to do first-class college work with an average expenditure of time and energy.

Exceptionally High Intelligence.—What a child of very high I.Q. can do, under favorable educational opportunities, is illustrated by a case reported by L. S. Hollingworth: E——, in 1916, was a boy eight years and four months of age, with an I.Q. of 187, and in Grade eight.

> "In addition to this regular school work the child has covered the following special work in language and mathe-

> matics, either with a tutor or with his mother: Geometry, algebra, as far as equations; Latin, partial knowledge of the four declensions (he has been taught by the direct, informal method, and reads easy Latin); Greek—worked out the alphabet himself from an astronomical chart, between the ages of five and six years; French, equal to about two years in the ordinary school; German, ordinary conversation; Spanish, attended class with his mother,—reads and understands; Italian, reading knowledge, simple conversation; Portuguese, asked his mother to take this language at the Columbia summer school because he could not be registered himself; Hebrew, a beginner; Anglo-Saxon, a beginning. In astronomy he has worked out all the constellations from MacCready, and displays a very great interest in this subject. One evening this winter he noticed a new planet near the Twins. He said it was Saturn, but his mother thought it was Mars. E——went home, worked the position out from the chart, and found it to be Saturn. He has a great interest in nature, wherever found, and is already able to use Apgar intelligently. His writing is not equal to his other accomplishments. He is very slow at it and for this reason dictates most of his 'home work' to a stenographer. History is his chief and absorbing interest among school subjects."

At the age of nine E—— had completed the work of Grade nine; at eleven years and ten months, graduated from high school; and at the age of thirteen had completed three semesters of work in Columbia College. He graduated with a Phi Beta Kappa key and other scholastic honors, a few days before his fifteenth birthday, and matriculated for the Ph. D. degree before he was sixteen. In capacity for scholastic achievement, this boy greatly surpasses the average.

In sum, there is impressive evidence that general intelligence as measured by the Stanford-Binet tests indicates with a faithfulness that makes it extremely useful practically the rate at which children learn *most school* *functions.* It sets a limit to the kind, difficulty or complexity of mental functions that can be acquired, and it sets a limit to the rate and permanence with which acquisition, within these limits, may go on. Algebra and geometry as now taught, for example, are beyond the mental capacities of many, and among those who find these functions within the limits of their capacity, individual differences in the rate, comprehensiveness and permanence of learning will be found, due to differences in endowment.

INTELLIGENCE AND PARTICULAR SCHOOL SUBJECTS

While the results of the Binet tests indicate very well the probable achievements in school work as a whole, they are not equally symptomatic of capacities in the particular subjects. The degree to which the tests indicate capacity in the several school functions is suggested by the coefficients of correlation between test scores and actual attainments. Taking as groups children in the same grades, Burt found the following average correlations:

CORRELATION BETWEEN	
Intelligence and composition	.63
Intelligence and reading	.56
Intelligence and arithmetic (problems)	.55
Intelligence and spelling	.52
Intelligence and writing	.21
Intelligence and handwork	.18
Intelligence and drawing	.15

These correlations show that the Binet tests do not measure native capacity in all scholastic lines equally well. The tests correspond quite closely to the children's ability in the linguistic and abstract subjects—composition, reading, spelling, arithmetic. Children with high

I.Q.'s are generally superior to those of lower I.Q.'s in these subjects, but they are not markedly superior in writing, handwork and drawing, that is, in mechanical and motor abilities. It should be noted, however, that the correlations between the intelligence tests and the latter functions, though low, are nevertheless positive. In the long run, individuals with high Binet scores will excel the others even in these functions.

INTELLIGENCE AND VOCATIONAL SUCCESS

Intelligence, as measured by the Binet tests, is closely associated with general scholastic success, especially in subjects which demand linguistic ability and the acquisition and manipulation of abstract ideas. Whether the same relation holds between intelligence and success in vocations under the more complex situations of life, is a matter worthy of investigation.

A careful study (by Vanuxem) of women sixteen or more years old in an institution for the feeble-minded shows clearly that in the lower levels there is a close relation between Stanford-Binet I.Q.'s and the complexity of vocational tasks which can be learned. In this study, attempts to teach women different tasks were made and the approximate minimum I.Q. required to learn to do each task satisfactorily was determined. The minimum I.Q.'s for each of various jobs and the average time required to teach the women are given in the accompanying table. A survey of this table shows that the more complex the job, the higher the I.Q. needed to learn to do it. For example, while women of I.Q.'s less than 25 can do certain very simple tasks, they are unable to do simple cooking, make beds, or wait on table, which require shifting from one to another of several different—even if simple—activities.

THE MINIMUM INTELLIGENCE QUOTIENT OF WOMEN OVER 16 YEARS OF AGE REQUIRED TO DO VARIOUS JOBS IN AN INSTITUTION FOR THE FEEBLE-MINDED

(After Vanuxem)

APPROXIMATE MINIMUM I.Q.	TIME OR NUMBER OF TRIALS TO LEARN	TASK OR VOCATION
10–20	15 trials	Fetch and carry a single object, *e.g.*, chair.
	1 day	Pick up stones, trash, etc., from lawn or walk.
	3 days	Pull up *one kind* of weed from garden.
20–25	6–8 days	Scrub floors or dust.
	16 trials	Carry out standardized simple errand.
	3 days	Pick *one kind* of fruit or vegetable.
	5 days	Pick *two kinds* of fruit or vegetable.
	8 days	Saw wood.
	5 days	Plant *one kind* of vegetable.
	5 days	Sort and hang up clothes.
26–30	7 days	Do simple hand washing.
	11 days	Do general cleaning.
	18 trials	Do dishwashing.
	18 days	Tend chickens.
31–37	8 days	Wash clothes by hand.
	6 days	Pare and wash potatoes, etc.
	19 trials	Darn stockings, do simple crocheting.
	18 days	Milk cow.
	17 days	Do hand ironing.
	52 trials	Make beds.
38–44	14 days	Do sheep herding.
	34 days	Do simple cooking.
	29 trials	Do simple hand sewing and mending.
	25 trials	Wait on table.
45–55	19 days	Help around farm.
	29 trials	Do shampooing.
	113 days	Do simple dressmaking.
	9 days	Embroider.
	65 days	Paint barns, etc.
	89 days	Do simple carpentry.
60–70	19 days	Plow.
	25 days	Do general farmwork.
77	11 days	Do general housework.

Unfortunately, the number of normal and superior adults that have been measured by the Stanford test is limited. The test was not designed for adults. The Army

Alpha, which was devised for this purpose, should yield results that are suggestive at least. The average scores on the Army Alpha test obtained by various occupational groups are shown in the following table.

SCORES [1]	OCCUPATIONS
40 to 49	Farmer, laborer, general miner and teamster.
50 to 58	Hostler, horseshoer, tailor, barber, general carpenter, painter, truck chauffeur, baker, cook, concrete or cement worker, mine drill runner, bricklayer, cobbler.
60 to 69	General machinist, lathe hand, general blacksmith, brakeman, locomotive fireman, auto chauffeur, telegraph and telephone lineman, butcher, bridge carpenter, railroad conductor, railroad shop mechanic, locomotive engineer, laundryman, plumber, auto repairman, pipe fitter, auto-engine mechanic, tool and gauge maker, stock checker, detective and policeman, tool-room expert, gunsmith, marine engineman, hand riveter, telephone operator.
70 to 79	Truckmaster, farrier and veterinarian, receiving clerk, shipping clerk, stockkeeper.
80 to 89	General electrician, telegrapher, band musician, concrete construction foreman, photographer.
90 to 99	Railroad clerk, general clerk, filing clerk.
100 to 109	Bookkeeper, army nurse, mechanical engineer.
110 to 119	Mechanical draughtsman, accountant, civil engineer, Y.M.C.A. secretaries, medical officers.
Over 120	Army chaplains, engineering officers.

When comparisons of radically different vocations are made, there is at once perceptible a tendency for vocations which require facility in dealing with words and symbols to stand higher than those which require aptitude for manipulating things and mechanisms. The clerical workers in general excel those engaged in mechanical occupations. The tests appear to have a verbal and linguistic bias; to favor those skilled in handling words and symbolic concepts as contrasted with those proficient in motor and mechanical abilities. This tendency appears both in the results of measurements of vocational groups and in the results of comparisons of attainments in school subjects.

Further examination of the data, however, will disclose the fact that the intelligence test measures abilities which possess a wider significance. Making comparison within a similar type of occupation, the more skilled workers appear to stand higher on the intelligence scale than the less expert. The mechanical engineer and draughtsmen are above 110, the general electrician and construction foreman score about eighty-five, the workers on more specific tasks, such as automobile repairman, plumber, toolmaker, bridge carpenter, auto chauffeur, etc., are below seventy, while the unskilled laborers are at the bottom of the list. Among the several types of clerical workers, a similar correlation between intelligence and occupational levels exists. The chaplains excel the Y.M.C.A. secretaries, the accountants surpass the bookkeepers, the medical officers are superior to the army nurses. Thus within similar occupational lines, general intelligence is associated with levels of proficiency. This result is probably due to the fact that the better the position the greater the need for ability to deal with abstract facts.

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[1] These are raw scores and not I.Q's.

It is significant that the members of the professional classes nearly always rank high in intelligence tests. In this connection, the average Army Alpha ratings of the students in various departments of a representative state university will afford interesting comparison with those of the occupational groups, just given.

MEDIAN ALPHA SCORES OF VARIOUS DEPARTMENTS IN OHIO STATE UNIVERSITY

(5950 Students)

DEPARTMENT	SCORE
Liberal Arts	147
Medicine	142
Law	142
Engineering	141
Agriculture	133
Pharmacy	125
Dental College	115
Veterinary College	112

The medians of the students in most of these professional courses are well above all of the army occupational groups except the professional classes. A relatively high degree of general intelligence of this type is probably essential to success in the ministry, law, editorial work, medicine, banking, engineering and other vocations for which college training is required.

INTELLIGENCE AND SOCIAL ADAPTABILITY AND LEADERSHIP

Between intelligence scores and general school success, there is a substantial correlation; between intelligence and vocational success a marked, but as yet not thoroughly appraised, association. What is the influence of abstract intelligence upon social adaptability and leadership, upon ability to get along with and manage people?

The use of the tests in the Army provided material that suggests a fair correspondence between fitness for managing and leading men and intelligence ratings. The students of the Officers' Training Schools who succeeded in earning commissions were on the average of higher intelligence, according to the tests, than those who failed. Among noncommissioned recruits in the cantonments, fitness for advancement as judged by officers corresponded fairly closely with intelligence scores. Finally, the average intelligence of seasoned troops corresponded fairly closely with military rank. In one group, which included approximately 30,000 men, the privates obtained an average Alpha score of approximately 73, corporals 95, sergeants 107 and commissioned officers 139. The overlapping of the intelligence scores of one rank upon others was great, however.

Many studies have been made to ascertain the correspondence of intelligence and social adaptability, leadership, popularity, etc., in the case of children. These results show much the same general relations as those obtained on adults in the army. All lead to the conclusion that intelligence indicates in some degree, but by no means perfectly, the capacities required in understanding, getting on with and managing other human beings.

There is some evidence, however, that the typical social leader is a person brighter than the average but not the very brightest. The person with an I.Q. between 105 and 115 is bright enough to do better than the person of average I.Q. and yet not so far away from the average people as to be extremely different from them in intellectual abilities and interests. If you glance at the Normal Surface of Distribution (p. 491) you will see that the majority of children lie near the average. A person of 110 I.Q. is not so far above the average as to be of vastly different interests and ability from the average; a person of 150 I.Q. is very distant from average and duller people,—so distant as to be of decidedly different abilities and interests. A person, especially a young one, so far out of touch with the general population of his age is more likely, other traits being equal, to be not so well understood and not so highly favored. The favorite is often a person of less intellectual endowment who is "more like the bunch." This does not mean that extremely bright children are conceited. They are rarely conceited but often puzzled as to why they differ as they do from the majority.

INTELLIGENCE AND MORAL ADJUSTMENTS

Fine gradations of moral adjustments are difficult to obtain. We may seek for some evidence in the studies of the relation of intelligence to delinquency and crime. Of the many individual studies, one made by Burt will be considered first, because it is based upon children who can be more adequately measured than adults, second, because it is probably fairly typical and third because of the care with which both intelligence and other abilities were measured. The group comprises 107 juvenile delinquents, ages six to fifteen, whose misdemeanors include theft, begging, truancy, assault, sexual offenses, damage to property and general incorrigibility. The average chronological age of the entire group was 13.2 years, the average mental age 11.3, thus giving an average retardation of two years in mental age or an average I.Q. of 85.6. Analyzing the distribution further, it is found that 7 per cent might be classified as "feeble-minded"; 20 per cent as very dull; 44 per cent as less dull but below average; 27 per cent as about average; and only 2 per cent as slightly above average. Supernormal intelligence among children is not incompatible with delinquency; but delinquents of high intelligence are rare. While the proportion of feeble-mindedness in the delinquent group is not great, it is at least five times as great as the proportion of feeble-mindedness in the total population. The more significant fact, however, is that the delinquent group, as a whole, is a dull group; only 2 per cent are above the average.

In Burt's study, the educational attainments of the delinquent children were appraised by objective tests with results most significant. The retardation in school attainments is twice as great as the retardation in mentality; namely, the equivalent of nearly four years. With a chronological age of 13.2, the educational achievements of these children were those of average children of 9.5 years. Not a child was above the average of his life age in school attainment; only 5 per cent were approximately equal to it; a fifth were slightly below, and three-quarters were retarded by 30 per cent or more.

Typically, then, the delinquent child is a dull child but not all dull children are delinquent. Social and moral deficiency is explained by dullness plus something else, or, probably, plus several other things. To some extent, the other traits are probably emotional and temperamental deficiencies or nervous instability. The compelling drives of the dominant urges, the incapacity for sustained effort, fickleness of interest, or the disrupting effects of unstable but impulsive emotions when combined with dullness of mind provide an organism readily susceptible to misdemeanor and crime. Many delinquent children are, however, not obviously instable or excessively impulsive or deficient in restraint. Environmental factors—unfavorable home, school or street influences—are sometimes the inciting causes.

Conclusions

The results of tests, such as the Binet or the Army Alpha, together with studies of the inheritance of mental traits lead to the assumption of general intelligence. By intelligence is meant a group or composite of native capacities for learning along the lines that require mental operations with verbal, symbolic and abstract materials. In these fields, the more intelligent person learns more rapidly, displays greater mental keenness, accuracy and control in meeting new problem-situations, and is capable of ascending to higher levels of achievement than the less intelligent person.

The intelligence tests do not measure all types of capacities to learn, but those which are tested are of great importance. Upon such capacities mainly depends achievement in school and colleges and success in many vocations. Social adaptability, proficiency in managing people and effectiveness of moral adjustments are also associated to an appreciable degree with this type of intelligence. The association of intelligence and ability to acquire various mechanical and motor skills—writing, drawing, painting, athletics and various mechanical trades—is positive but low.

USES OF INTELLIGENCE TESTS IN EDUCATION

The facts concerning intelligence, as a concept, and intelligence tests, as a practical instrument for approximating measures of native intellectual capacity suggest many useful educational practices and theories. Since the application of these facts to general educational objectives and theories falls primarily within the province of educational philosophy and the technical uses of tests within the field of special courses in testing, we shall merely suggest, rather than fully describe, certain types of implications.

Adjustment of the Individual to the Conditions of Life.—Nearly every practical use of intelligence tests may be considered as an instance of putting into effect the following principle: *Each individual's life will be most fruitful to himself and to society when his activities are nicely adjusted to his native capacities.* This principle was illustrated and defended during the discussion of interest and efficiency in the preceding chapter. While the intelligence tests do not measure all forms of native aptitude, they do reveal fairly well a very important and far-reaching type of capacity. Some of the particular applications of this general principle which available intelligence tests make possible are as follows:

Classification of Pupils into Homogeneous Groups.—In the first section of this chapter we observed that pupils in a typical grade differ widely in intelligence. Since assignments, lessons and methods of teaching are usually the same for a whole class, it is obvious that they cannot be "nicely adjusted to the intellectual capacity" of every pupil. An activity, or problem, or discussion that is nicely adjusted to the capacity of the average pupils is likely to be so easy as to bore the brightest and so hard as to perplex the dullest. It follows, therefore, that it will increase the interest and efficiency of all pupils to classify them as nearly as possible into homogeneous groups. The Mental Age, which indicates the *level* of intellectual capacity at the time, is a measurement well suited to this purpose.

Sectioning According to Rate of Progress.—Pupils alike in Mental Age will differ in Intelligence Quotients or brightness. Thus a child with an I.Q. of 125 will reach the M.A. of ten when he is eight years old whereas a pupil with an I.Q. of 75 will not reach an M.A. of ten years until he is thirteen and a third years old. These two children will differ at least in one respect. The younger, brighter child will grow more in intellectual capacity during the school year than the older, less bright one. The former will gain 1.25 years M.A. and the duller .75 year M.A. during a calendar year. At the end of the year the former will have an M.A. of 11.25 and the latter 10.75. This fact points to the advisability of dividing pupils into *sections* which are not only composed of pupils having as nearly the same M.A. as possible but also of pupils having the same I.Q. so that they can advance together at a similar rate. Thus in a large school one may find several sections at each grade level: (1) a very bright, (2) a bright, (3) an average, (4) duller than average and (5) a dullest group.

The principle of advancing pupils at a pace that enables them to work at the level most suited to their intellectual status is a sound one. That our system of teaching children in large classes makes it difficult to put this principle into effect is the fault of the system and not of the principle.

Adjusting Subject Matter and Methods to Intellectual Capacity.—The treatment of bright, average and duller groups should vary in more than mere rate of pace. The brighter pupils are capable not only of learning by short-circuited methods but also of generalizing and applying their knowledge to wider and more distant situations. They are more able and anxious to abstract the essence of the experiences incorporated in the "minimum essentials" of the curriculum and more able and anxious to explore other intellectual fields. Thus at the age of eight a child of 150 I.Q. is likely to be greatly concerned about and interested in studying and discussing such subtle problems as the significance of life and death, the present, future and hereafter. A child with an I.Q. of 150 at the age of 8 has a mental age of 12 years which the *average* person reaches in early adolescence. These problems which may be among the primary causes of the "stress and strain" typical of the average person's adolescent years become vital to the very bright child several years earlier. Persons of I.Q.'s below 80 probably rarely ever become much interested in these problems because they are intellectually incapable of appreciating their existence in more than a dim way. Thus adjustment of the curriculum to intellectual differences requires variations in methods and substance as well as in pace of advancement.

Adjustment to Vocational and Other Prospects.— Since we observed above that intelligence enters into vocational, social and other phases of life, it follows that measures of intellect may be used to help a pupil find the kind of life work, the types of recreational activities, the forms of social and political service which will make him most happy and productive and which will contribute the most to the welfare of society. The practices of vocational, recreational and social guidance are not yet far advanced but the facts and principles here revealed show that there is a sound psychological foundation for them. The development of effective methods of discovering and adjusting education to the individual's vocational, recreational and social possibilities should enormously increase human welfare.

Use of Intelligence Tests in Appraising Degrees of Efficiency.—A final general service to which intelligence tests may be put is that of increasing the *fairness* of an appraisal of efficiency. Mere measurements of the amount of achievement are never, in one important respect, a fair measure of efficiency. If in city A., the average mentality of the pupils is low, to condemn the school, the superintendent, the teachers and the pupils, any one or all of them, for inefficiency would obviously be unfair. It would be equally unjust and misleading to praise the high efficiency of every one connected with a school in which pupils, while attaining achievement scores five per cent above the average, were ten per cent above the average in native endowment. Intelligence tests may be used to increase the fairness and the usefulness of estimating the proficiency of a given pupil, teacher, of a given class, or grade, or school, or city, or country, state or national school system. Certain further instruments and devices needed for such diagnoses and surveys will be discussed in the next chapter.

QUESTIONS AND EXERCISES

1. Draw a curve of distribution which will show how we distort the facts when we assume that individuals are divided into types.

2. It has been proposed, inasmuch as individual differences in achievement in college courses are so great, that a scheme of "credit for quality" be adopted. For example, for a grade of A the credit should be 4; for B, 3; for C, 2; for D, 1 and for F, 0. Defend or oppose this proposal.

3. In physical recreation in college, should all students be given the same amount and type of exercise?

4. Criticize or defend each of the following practices:
   (a) Insisting on a long march that all keep step.
   (b) Organizing companies in the army to get together those of as nearly equal height as possible instead of having a range of heights in each company.
   (c) Assigning all students the same length of time to master an assignment.
   (d) Dividing large college classes into several sections according to their general scholastic ability in the subject in question.
   (e) Having the brighter students in this course do fewer exercises than the duller.
   (f) Having a fixed rule in college that all full-time students must take sixteen points; no more, nor less.
   (g) Having a rule that anyone who passes all examinations gets credit for the course without regard to attendance.

5. Under what conditions, according to the text, does a test of various "higher" mental activities become a measure of mental capacity? Describe conditions under which certain exceptional children may be living which would make the intelligence test an invalid measure of native mental capacity. What do you consider the most important fact or principle offered in this chapter?

6. Following are definitions of intelligence offered by other writers. Which of these are most serviceable and valid?
   (a) "The general capacity of an individual consciously to adjust his thinking to new requirements."—Stern.
   (b) "An individual is intelligent in proportion as he is able to carry on abstract thinking."—L. M. Terman.
   (c) "To judge well, understand well, reason well, these are the essentials of intelligence."—Alfred Binet.
   (d) "Intelligence seems to be a biological mechanism by which the effects of a complexity of stimuli are brought together and given a somewhat unified effect in behavior."
   —Joseph Peterson.

7. Basing your opinion on the facts presented in the chapter, does it appear that the definitions above are too broad or too narrow to *define* what the present tests actually measure?

8. Aside from tests, what features or kinds of behavior disclose in some measure the degree of intelligence that a person may have? For example, are table manners or English usages indicative of intelligence?

9. In which of the following types of work is a high degree of intelligence probably useful or necessary: driving an automobile, fishing with nets, splitting wood, taking shorthand dictation, barbering, preaching, teaching, running a riveting machine, writing poetry, selling toy balloons, selling bonds. In which of these activities are traits other than intelligence important? What traits?

10. What services could an expert in intelligence testing render to the work in: (a) a juvenile court; (b) a hospital for neurotic children; (c) a public school; (d) a criminal court; (e) a home for orphans; (f) an automobile factory; (g) a large department store; (h) an immigration bureau; (i) the army or navy?

11. Explain in some plausible way the fact that intelligent people, on the whole, are less conceited than are dull.

12. To what extent are the factors which are involved in reasoning also involved in taking intelligence tests? Do you think the reasoning tests given on pages 411–412 would make good tests of general intelligence?

13. A boy of 10 with an I.Q. of 140 would have what mental age? A boy of 14 with an I.Q. of 100? In what respects would these two boys resemble each other or an adult with an M.A. of 14? In what respects would the three be very unlike?

14. Carefully distinguish between intellectual capacity and achievement.

15. In what ways should the methods of teaching bright children differ from those used with dull children? What subjects will the bright probably find most interesting? Which will the dull like best?

16. Comment on this statement, "It may be of greater value to society to discover a single gifted child and aid in his proper development than to train a thousand dullards to the limit of their educability."

17. How would you explain the fact that children of superior intelligence when graded with those of the same age occasionally become mischievous, lazy or bored with school work? Does the occasional report of an eminent man getting along badly in school, if true, necessarily prove that such men were stupid when young or that they were unable to do school work?

18. If students were promoted in school from kindergarten to college at a rate corresponding to their mental development, what difficulties of administration would be encountered? What, if any, difficulties in social adjustments?

19. Is it your experience that the more intelligent people are more or less socially adaptable? How would you explain the exceptional cases?

20. How might intelligence tests be used in vocational guidance? When should they be so used?

21. When a person's I.Q. becomes higher or lower on a retest, does it necessarily mean that his intelligence has changed correspondingly?

22. Arrange the various uses of intelligence tests in order from most to least important. What other uses can you suggest?

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CHAPTER XVI

ACHIEVEMENT AND CAPACITY

At the conclusion of the preceding chapter it was stated that intelligence tests could be employed to increase the fairness and usefulness of appraisals of the efficiency of an individual or group of individuals. For such an appraisal to be just and valuable it is necessary also to use fair and useful measures of achievement. In this chapter we shall therefore consider means of measuring acquired abilities and attainments.

THE UNRELIABILITY OF SUBJECTIVE ESTIMATES OF EDUCATIONAL ATTAINMENTS

Subjective estimates of human abilities and capacities are far from reliable. The subjective methods of grading scholastic attainments is no exception to this rule. For example: In an experiment, two final examination papers in first year high school composition were graded by 142 English teachers in as many high schools; a final examination in geometry was graded by 114 teachers of mathematics and a final examination in American history by 70 teachers in history—all grading being on a percentage basis. Representative variations in scores are shown in Figure 43. The marks of the first English paper ranged from 64 to 98; of the second from 50 to 98; of the geometry paper from 28 to 92; and of the history papers from 43 to 90. That these variations were not due mainly to differences in standards in different schools has been shown by similar studies of teachers in the same school or college. The deviations are nearly as great. Even when a teacher after an interval regrades a set of papers, the marks differ appreciably from those of the first scoring. Later investigations have shown these results to be rather extreme, but a marked degree of unreliability is usually found.

The causes of such conspicuous variations in grading are many. Teachers have different general standards, lenient or severe, and these may vary considerably from time to time. Different degrees of importance are attached to the many items—penmanship, spelling, grammar, terseness, particular facts, general understanding. Judgments of the relative difficulty of the questions or problems in an examination are often faulty. Among twenty sixth-grade teachers, each of whom judged the relative difficulty of 23 arithmetic problems, there was great disagreement: Problem 1 was placed by some teachers in various positions from the easiest to the eighth in difficulty; problem 12 from the fourth to the seventeenth; and problem 23 from the first to the twenty-first. Familiarity with the work of a group of pupils usually reduces the validity of grading products of those pupils, some of whom become stamped as generally excellent,

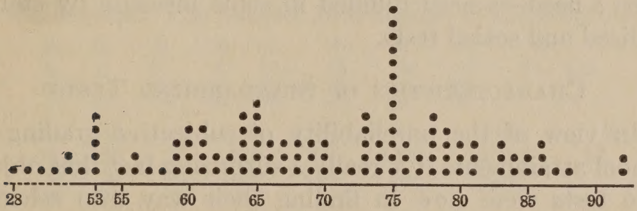


Fig. 43.—Distribution of Marks Assigned to a Final Examination Paper in Geometry by 114 Teachers of Mathematics. Each dot represents the mark given the paper by one teacher. Marks represent percentages of excellence. (From Starch, *Educational Psychology*, after Starch and Elliott.)

others as fair or poor; and these general estimates unwittingly pervade the judgments of the particular tests. The good pupils in general are not marked down as much as they should be when their showing is relatively poor and the poor pupils are not marked up as much as they should be for exceptional performance. All told, subjective judgments of school products are found to be strikingly inaccurate. For more reliable, more comprehensive appraisals of educational attainments there clearly has been a need—a need fulfilled in some measure by standardized and scaled tests.

CHARACTERISTICS OF STANDARDIZED TESTS

In view of the unreliability of subjective grading of school attainments it is really a surprising fact that objective tests were slow in finding their way into schools. Prior to 1890, objective tests of various abilities, including arithmetic, reading and other school abilities, were used in psychological laboratories. About 1900, Thorndike began to develop the techniques and typical instruments needed to make practicable the use of objective methods in measuring educational attainments in schools. To the energy and genius of this man we are indebted for most of the fundamental principles and the enthusiasm which have resulted in the rapid advance and spread of the use of educational measurements. Since Thorndike's invention of the educational *scale*, about 1908, the first forms of which were published in 1909 and 1910 by Thorndike and his students, the movement has been one of prodigious proportions.

Standardized Tests.—The first requirement for objective measurement is a *standardized test*. Any series of questions, exercises, problems or performances constitutes a *test*. When the procedure for conducting the test, the instruments, time and methods of scoring are definitely prescribed we have a *standardized test.* A test may be arranged to measure (1) the difficulty or altitude, (2) the range, (3) the speed, (4) the accuracy or (5) the quality of performance. A few illustrations will make these clear.

Difficulty or Altitude Tests.—This type of test is designed to determine how difficult a task a person can do or how difficult a problem he can solve. The test consists of a series of exercises arranged in order from the easiest to the hardest. The subject then begins at the easy end of the test and goes as far up the scale as he can in the time allowed, which is usually liberal. This procedure, which will be recognized as the one adopted in the Binet Intelligence Tests, has been applied to many tests of scholastic attainments. There are tests of this type designed to measure how difficult a passage a pupil can comprehend, how hard a word he can spell or define, how difficult a problem in arithmetic, algebra or history he can solve, how

(1) $\begin{array}{r} 8 \\ \underline{5} \end{array}$
(2) $\begin{array}{r} 6 \\ \underline{0} \end{array}$
(3) $\begin{array}{r} 2 \\ \underline{1} \end{array}$
(4) $\begin{array}{r} 9 \\ \underline{3} \end{array}$
(5) $\begin{array}{r} 4 \\ \underline{4} \end{array}$
(6) $\begin{array}{r} 11 \\ \underline{7} \end{array}$
(7) $\begin{array}{r} 13 \\ \underline{8} \end{array}$
(8) $\begin{array}{r} 59 \\ \underline{12} \end{array}$
(9) $\begin{array}{r} 78 \\ \underline{37} \end{array}$
(10) $7 - 4 =$
(11) $\begin{array}{r} 76 \\ \underline{60} \end{array}$

(12) $\begin{array}{r} 27 \\ \underline{3} \end{array}$
(13) $\begin{array}{r} 16 \\ \underline{9} \end{array}$
(14) $\begin{array}{r} 50 \\ \underline{25} \end{array}$
(15) $\begin{array}{r} 21 \\ \underline{9} \end{array}$
(16) $\begin{array}{r} 270 \\ \underline{190} \end{array}$
(17) $\begin{array}{r} 393 \\ \underline{178} \end{array}$
(18) $\begin{array}{r} 1000 \\ \underline{537} \end{array}$
(19) $\begin{array}{r} 567482 \\ \underline{106493} \end{array}$
(20) $2\frac{3}{4} - 1 =$

(21) $\begin{array}{r} 10.00 \\ \underline{3.49} \end{array}$
(22) $3\frac{1}{2} - \frac{1}{2} =$
(23) $\begin{array}{r} 80836465 \\ \underline{49178036} \end{array}$
(24) $\begin{array}{r} 8\frac{7}{8} \\ \underline{5\frac{3}{4}} \end{array}$
(25) $\begin{array}{r} 27 \\ \underline{12\frac{5}{8}} \end{array}$
(26) $\begin{array}{r} \text{4 yd. 1 ft. 6 in.} \\ \underline{\text{2 yd. 2 ft. 3 in.}} \end{array}$

(27) $\begin{array}{r} \text{5 yd. 1 ft. 4 in.} \\ \underline{\text{2 yd. 2 ft. 8 in.}} \end{array}$
(28) $10 - 6.25 =$
(29) $\begin{array}{r} 75\frac{3}{4} \\ \underline{52\frac{1}{4}} \end{array}$
(30) $9.8063 - 0.019 =$

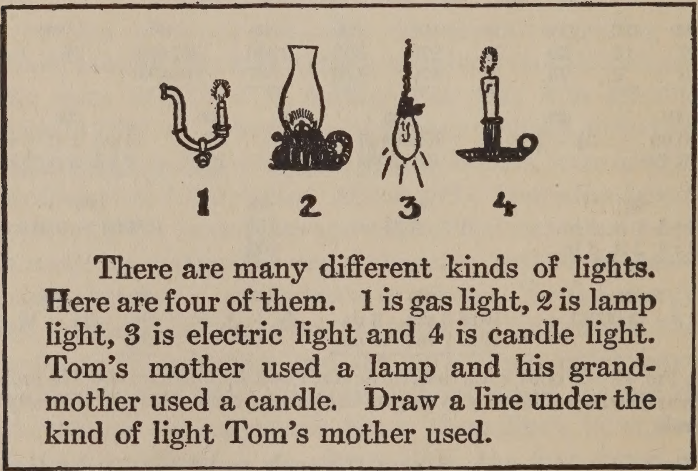
(31) $7.3 - 3.00081 =$
(32) $\begin{array}{r} \text{1912 6 mo. 8 da.} \\ \underline{\text{1910 7 mo. 15 da.}} \end{array}$
(33) $\frac{5}{12} - \frac{2}{10} =$
(34) $\begin{array}{r} 6\frac{1}{8} \\ \underline{2\frac{7}{8}} \end{array}$
(35) $3\frac{7}{8} - 1\frac{5}{8} =$

FIG. 44.—WOODY'S ARITHMETIC SCALE, FORM A, SUBTRACTION. The problems increase in difficulty by steps of known magnitude. This is a "difficulty" scale.

complex a stunt in athletics he can do, etc. These tests are sometimes also called *power* tests.

Range Tests.—The range of information or skill can be measured by determining the number of correct answers given or tasks done out of a total number of tasks of approximately the same difficulty. Such tests are made to survey the range of knowledge in history, or of ability in arithmetic or spelling and the like. In pure range tests, the time allowance should be liberal so as to eliminate the factor of speed which may be measured separately.

Speed Tests.—The speed test is usually designed to measure the amount of work of a uniform quality and difficulty that a pupil can do in a given time. The reading test, of which a sample is shown above, is composed of a number of exercises of the same length and difficulty. To keep accuracy constant, the score is the number of exercises read and correctly interpreted in a given time.



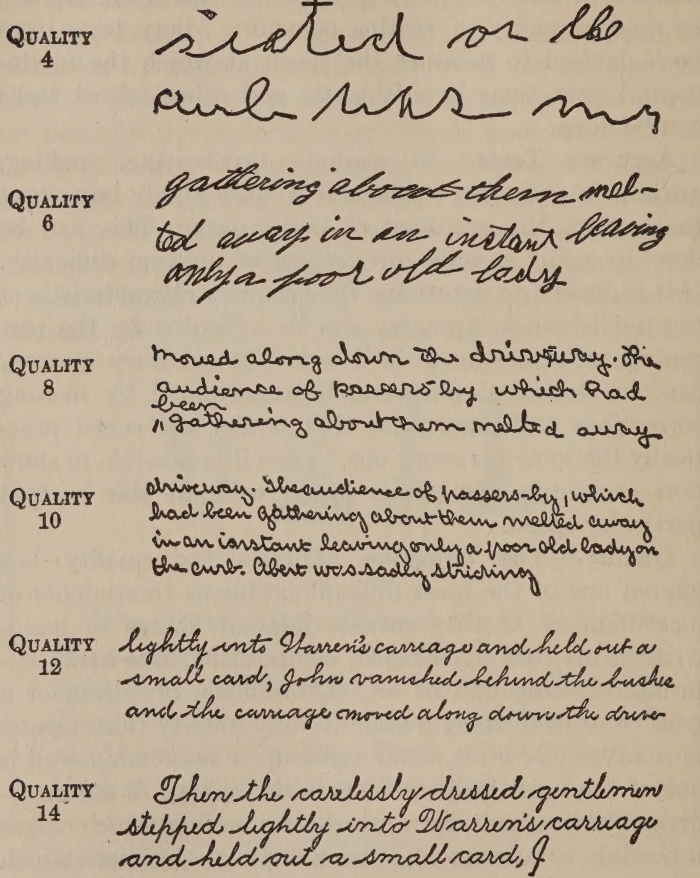
There are many different kinds of lights. Here are four of them. 1 is gas light, 2 is lamp light, 3 is electric light and 4 is candle light. Tom's mother used a lamp and his grandmother used a candle. Draw a line under the kind of light Tom's mother used.

Fig. 45.—Exercise from Gates Silent Reading Test. The test is composed of 24 exercises equal in difficulty to this one. The test measures speed of reading.

Handwriting speed can be measured by determining the number of letters written per minute and using devices to render quality of writing constant. Many tests have been devised to measure the speed at which the fundamental operations in arithmetic and other school tasks can be done.

Accuracy Tests.—In reading, typewriting, spelling, arithmetic and other subjects it is often highly important to measure the accuracy of performance. This can be done by using a series of exercises of uniform difficulty. If it is desired to determine the accuracy characteristic of the pupils' work, accuracy can be indicated by the percentage of errors made in a test. The accuracy of work can, for technical purposes, be determined by making corrections and allowances that render the speed practically the same for every one. Then it is possible to show how accurately the pupils would work at this or that particular speed.

Quality.—The objective appraisal of quality has offered one of the most difficult problems to students of measurement. Quality means different things in handwriting, art, sewing, English composition, free-hand lettering, drawing and so on. Thorndike's invention of a method of developing a scale for any quality that experts in a subject or craft could agree upon reasonably well is one of the most brilliant feats in the history of the measurement movement. He worked out a method which makes it possible to arrange in order a series of specimens which vary in quality from a very low degree to a very high degree by equal steps or at least by steps of known magnitude. The Thorndike Scale for Quality of Handwriting, the first of the type to appear, is shown in part on p. 436. Such a scale is used as follows: First the pupil is given a standardized test in writing. Competent judges



Quality 4

seated on the
curb [illegible] [illegible]

Quality 6

gathering about them mel-
ted away in an instant leaving
only a poor old lady

Quality 8

moved along down the driveway. The
audience of passers-by which had
been
gathering about them melted away

Quality 10

driveway. The audience of passers-by, which
had been gathering about them melted away
in an instant leaving only a poor old lady on
the curb. Abert was sadly striking

Quality 12

lightly into Warren's carriage and held out a
small card, John vanished behind the bushes
and the carriage moved along down the drive-

Quality 14

Then the carelessly dressed gentleman
stepped lightly into Warren's carriage
and held out a small card, J

Fig. 46.—Specimens from the Thorndike Scale for Quality of Handwriting. The samples are greatly reduced in size and only a few of the specimens at a few of the steps are shown. The original includes several specimens for each step from Quality 0 to Quality 18.

slide this sample up and down the scale, in a standardized way, until they find a sample on the scale which matches the pupil's product. The number, which indicates the degree of quality in that scale sample, becomes the quality score for this child.

It is apparent that this practice involves the subjective judgment of the person who compares the pupil's specimen with the scale. By systematically training, however, many persons can become very expert. Reliability can be further increased by securing the independent judgments of *several* experts.

Mixed Tests.—Tests, then, may be devised to measure how hard a task one can do, or how many facts or skills one has acquired or how rapidly or accurately or otherwise excellently one can perform. The speed, range, accuracy or quality of performance may be measured at any one of several levels of difficulty. Many tests combine measurements of these elements in different ways in order to secure a rough estimate of general all-round ability. Unless a test measures a single factor separately, with the others held constant, it yields only a rough and general measure. This point we shall refer to again after considering the problem of standards of comparison.

Standard Scales for Comparison

Every test, when corrected and scored, yields a numerical value or *score*. Thus Pupil A in grade 4 obtained the following scores: Speed of computation in arithmetic, 36; difficulty test in arithmetic, 17; speed of reading, 12; difficulty or altitude of reading comprehension, 22; accuracy in reading, 82; quality of writing, 10.5. These scores, usually called *raw* scores, obviously mean little as they stand. The reader doubtless has no idea whether A is on the whole good or poor for his age or grade or in what abilities he is relatively strong or weak. These raw scores can become meaningful only when considered with reference to some standard of comparison. They would obviously be most meaningful if all of the raw scores could be stated in terms of the *same* standard.

A suitable basis of comparison is a *standard scale.* A standard scale is one on which (1) abilities are arranged from the least to the most by steps of known (preferably equal) steps, (2) in which each step is expressed in quantitative form, and (3) into which raw scores from any test can be converted. With such a standard scale, raw scores from any test can be translated into *scale scores.* Thus Pupil A's raw scores, when thus converted, become the following scale scores:

Speed of computation, arithmetic	10.0
Difficulty of problems, arithmetic	11.0
Speed of reading	10.0
Power of comprehension in reading	12.0
Accuracy in reading	11.0
Quality of writing	12.0

Pupil A, then, is most proficient in reading comprehension and writing quality, least able in speed of computation and speed of reading and midway between the two extremes in arithmetic difficulty test and reading accuracy.

Types of Standard Scales.—Most of the standard scales now in use depend upon one of the following three types of comparison:

(1) Comparison of a pupil's score with the abilities of average pupils at *different ages.*
(2) Comparison of a pupil's score with the abilities of average pupils in *different grades.*
(3) Comparison of a pupil's score with the abilities of different pupils of the *same age or grade.*

The standard scales resulting from these three types of comparisons may be called the *Age Scale*, the *Grade Scale* and the *Variability Scale*. The methods of constructing such scales are so technical that no attempt will be made here to describe them. We shall merely try to indicate roughly what each type means.

The Age Scale.—The principle of the age scale for achievement tests is substantially the same as that underlying the mental age scale, previously illustrated in our discussion of the intelligence tests. Just as a score on the intelligence test can be translated into a Mental Age so a raw score obtained in an educational attainment test can be translated into an Educational Age. Likewise a score on a particular reading test can be converted into a Reading Age. To obtain an Educational Age of 10 years then means to have the educational ability of the average 10-year-old pupil; to have a Reading Age of 10 years means to be able to read as well as the average 10-year-old pupil.

The Grade Scale.—In the grade scale, the pupil's raw score is converted into an average grade status, instead of an age position. Thus if a pupil's score in an educational achievement test is equivalent to the average raw score of pupils at the beginning of grade 4, this pupil secures a grade score of 4.0; if his score is equivalent to the average score of pupils in the middle of grade 4, he will be given a score of 4.5 and so on. To secure a Reading Grade of 4.0 means to have the reading ability of the average pupil at the beginning of the fourth grade. In passing, it should be said that intelligence tests scores can also be converted into grade scores as well as age scores. Thus to have a Mental Grade score of 4.0 means to have the intelligence of the average pupil at the time of beginning the fourth grade.

Variability Scales.—The *variability scale* is a device which makes it possible to compare a pupil's raw score with those of other pupils of a given age (or grade). In the preceding chapter, we found that a group of pupils of a given age (or grade) differ widely in ability. If you have large representative groups of a given age (or grade) the scores vary from very low to very high in a way that approximates more or less closely the Normal Curve of Distribution (see preceding chapter). It therefore becomes possible to convert a pupil's raw test score into a number which indicates a pupil's position in this distribution or variability range. Thus, one may call the score of the average person, whose score would be at the middle of the group, variability score 50; and have other scores 49, 48, etc., running down to 0, the lowest, and others, 51, 52, etc., running up to 100, the highest, in such a way that all steps, from 35 to 36 or from 50 to 51 or at any other point on the scale are equal. Such a variability scale may be worked out from the distribution of pupils' abilities in any age, or in any grade. Probably the best known variability scale is the one (introduced by McCall) termed the T Scale. It is based on the distribution of 12-year-old pupils and yields a scale of equal steps from 0 to 100, in which 50 represents the ability of average pupils of this age. It may be added that scores from intelligence and other tests can be scaled in variability units as well as in age or grade units.

Relative Merits of Age, Grade and Variability Scales.—In a general way it may be said that the variability scales are most useful for precise, scientific work and that the age and grade scales are at present more suited to practical use in school systems. The merit of the variability scale is the greater equality of its steps. It approaches more closely the thermometer or footrule in which the steps on the scale, degrees of temperature or inches, are substantially equal. The limitation of the variability scale for practical school work is the indefiniteness of the significance of the scale as a whole. For ordinary use in practical hands the age scales and grade scales have proved to be distinctly serviceable. They have the advantage of embodying none but everyday conceptions; the average achievement as a basis, and the year or grade as units or steps. They are readily understood by parents as well as teachers; they are simply and speedily constructed. Both, however, are subject to a defect which becomes serious when results are required for scientific purposes. The defect is the fact that different units of such scales are of unknown magnitude; that is to say the step from the average of grade 3 to the average of grade 4 may be larger or smaller than the step from grade 4 to 5, or 5 to 6, etc. Similarly, the step from the average for 6-year-olds to the average for 7-year-olds may be different from the steps between the averages for any other two adjacent years. The size of a grade unit depends considerably, in certain subjects at least, upon the amount of time devoted to the subject. A radical change in the curriculum would change the units in a grade or age scale.

When it is important to know the magnitude of the age or grade units, the solution consists in determining these magnitudes by first constructing a variability scale and then constructing for practical uses age and grade scales. If anyone then wants to know the magnitude of the steps from 6 to 7, 7 to 8, 8 to 9 years (or grades) he can find it out by referring to the variability scale.

Meaning and Significance of Scale " Norms. "—The age, grade or variability scales which you see printed in the manuals for educational tests are sometimes called norms. You may hear one teacher expressing satisfaction because her class tested "above the norm" and another voicing dismay because her group fell "below the norm."

Every student should understand once and for all that these scales are ‘‘norms’’ only in a statistical sense; they are arithmetical averages and not ideals. The scales actually depict not ideal but average, or strictly speaking, mediocre attainment. Half of the pupils, approximately, equal or excel these ‘‘norms,’’ another half only equals or falls below them. The scales are not in any sense standards of excellences; they are merely standards for comparison. They enable one to compare any particular pupil’s attainments with the typical or average achievement. The scale ‘‘norms’’ throw no light whatever on the question whether the typical or median achievement in any subject is optimum, too high or too low.

Educational or Achievement Quotients.—You will recall that by dividing the Mental Age by the Chronological Age, the Intelligence Quotient or I.Q. is secured. In the same way, by dividing the Educational Age (E.A.) by the Chronological Age, the Educational Quotient (E.Q.) is secured; by dividing the Reading Age (or any other achievement age score) by the Chronological Age, a Reading Quotient is computed. The educational quotient is a neat way of showing by what percentage of the average achievement of pupils of the same age, an individual pupil’s educational ability is. For example:

Pupil A. Educational Age 8 ÷ Chronological Age 10 = Educational Quotient .80
Pupil B. “ “ 10 ÷ Chronological Age 10 = Educational Quotient 1.00
Pupil C. “ “ 12 ÷ Chronological Age 10 = Educational Quotient 1.20

Thus an E.Q. of .80 means that Pupil A’s ability is 80 per cent of the average attainment of pupils of his age. This pupil is, in other words, 20 per cent below average. Pupil B, with an E.Q. of 1.00 is of exactly average ability and C, with an E.Q. of 1.20 is 20 per cent above the average.

The Educational Quotients thus obtained from 689 pupils by using tests of reading, writing, spelling, arithmetic and composition as a measure of Educational Age and the Binet as a test of intelligence by Burt are shown in the following table:[1]

EDUCATIONAL QUOTIENTS	PERCENTAGE OF PUPILS
60–69	1.1
70–79	4.2
80–89	11.3
90–99	33.5
100–109	36.4
110–119	11.2
120–129	2.3
130–139	0.0

Seventy per cent of the pupils cluster closely about the average achievements, from E.Q.'s 90 to 109, with a scattering to the lower extreme somewhat greater than that to the upper extreme. Such differences in achievement are caused in large measure, as we observed in the previous chapter, by differences in general mental capacity.

Burt also obtained the Intelligence Quotients of these pupils by means of the Binet test. Generally speaking, relatively high intelligence goes with relatively high achievements, average intelligence with average achievements, low with low, as indicated by a coefficient of correlation of 0.74; a figure which indicates a very substantial correspondence between intelligence and achievement.

THE ACCOMPLISHMENT QUOTIENT

The important matter is the amount a pupil accomplishes in proportion, not merely to his age, but to his *capacity*. A pupil of high capacity ought easily to excel a pupil of low aptitude. For a pupil of less than average capacity to equal the average achievement should represent an admirable investment of limited capital; for a pupil of better than average talent merely to equal the average proficiency would represent a poor investment of superior resources. To know what any pupil is doing with the capacity at his command is of extreme importance. The Accomplishment Quotient is a technique of computing, practically speaking, the ratio of ability and capacity. The procedure requires first that capacity and ability be measured independently but expressed in terms of the same scale. Thus intelligence, as a measure of mental capacity, and scores on scholastic tests, as a measure of educational ability, may both be expressed in age scores, grade scores or variability scores. Given intellectual capacity and educational ability in terms of the same scale, the Accomplishment Quotient (A.Q.) is obtained by dividing the latter by the former. For example, suppose both are expressed in age scores, as in these following cases:

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[1] Adapted from Table XIX of Burt, *Mental and Scholastic Tests*, p. 177.

Pupil A. E.A. 8 ÷ M. A. 9 = A.Q. .89
B. E.A. 10 ÷ M. A. 10 = A.Q. 1.00
C. E.A. 10 ÷ M. A. 9 = A.Q. 1.11
D. E.A. 11 ÷ M. A. 13 = A.Q. .85

Pupil D, who has the highest educational age, has really displayed the least efficiency of the four; his A.Q. of 85 means that his achievement status is 15 per cent below his capacity status. Pupil C, although his ability is less than that of D, has invested his capacity better than anyone else; his A.Q. of 111 shows that he has accomplished, in proportion to his native aptitude, approximately 11 per cent more than the average pupil does. Pupil B pictures the average efficiency; his ability score just equals his capacity score. His A.Q. is therefore 1.00. Pupil A falls below average efficiency by the same amount that C exceeds it; namely, by approximately 11 per cent. Thus it may be seen that the Accomplishment Quotient provides a means of determining the amount of achievement in comparison with capacity. It provides a just basis for competition and reward. By its use, the most poorly endowed pupil in the class may demonstrate his superiority to the best endowed by making of his limited talents the most productive use. Any pupil, bright, average or dull, who shows a low A.Q., is in need of diagnosis to discover and remove, if possible, the sources of inefficiency.

As a *psychological principle*, the Accomplishment Quotient idea is sound. As statistical devices, the present A.Q. techniques are subject to certain defects. These defects, being technical ones, will doubtless be removed in time. In the hands of competent persons, the techniques now available are accurate enough to make possible many important practical services in education. The general theory of appraising acquired ability in comparison with native capacity is applicable to any type of attainments—scholastic, vocational, social, moral, artistic, athletic, etc., to the extent that both ability and capacity in any given function can be measured and expressed quantitatively in terms of a single, valid scale. To what extent the procedure can be applied at present will be suggested in the surveys of tests to be given in this and the next chapter.

CLASSIFICATION OF ACHIEVEMENT TESTS

Tests Vary in Reliability.—Most of the tests of educational attainments can be classified on a threefold scale. They may be placed on a scale which ranges from one extreme at which the instrument is relatively short and of relatively low reliability to the other extreme at which the test is long, refined and highly reliable. At the first extreme would be tests suitable for survey purposes. Some are only reliable enough to yield a valid measure of the average attainment of a large group of pupils such as 500 in each grade in a school system. Such a test would be quite inadequate to measure the ability of a single child or even of a single class. At the other extreme would be found many tests sufficiently long and refined to measure reliably enough for most purposes the attainment of an individual pupil.

Tests Vary in Specificity.—The tests also vary from those designed to measure scholastic ability in a general way to instruments constructed to determine a very specific ability. An excellent sample of the first type of test is Pintner's Educational Survey Test which contains exercises in reading, arithmetic, history, geography, language and other subjects. The purpose of this test is primarily to obtain a total score which will represent the *general* educational status (the Educational Age, or grade, for example) of a pupil, class, school or larger unit. Another step on the scale of specificity would be represented by such tests as Woody's Arithmetic Test which is composed of miscellaneous problems in such a way as to indicate fairly well all-round ability in arithmetic. Still further along the scale would be such a test as the Stanford Achievement Test which measures two or more aspects of each of several subjects. Thus arithmetic is divided into a difficulty test of arithmetic reasoning and another for arithmetic computation; reading is divided into two difficulty tests, one for the understanding of paragraphs and one for the understanding of words of increasing difficulty. Still more specific would be such tests as the Compass Diagnostic Tests in Arithmetic or the Gates Diagnostic Tests in Reading, both of which were developed to measure separately a large number of relatively specific abilities involved in each subject. The Compass Tests include ninety different tests. Each test measures a relatively specific ability such as the additions of numbers under 10, or the addition of higher decades, or column addition, or carrying in column addition, or checking answers in addition.

Tests Vary in Validity.—Tests also vary in validity. By validity is meant the degree to which a test really measures what it was designed to measure. An investigation once revealed the fact that in a test composed of simple problems in addition and designated as a "speed of computation" test most subjects could add the figures faster than they could write the answers. The score was consequently a measure of speed of *writing* rather than of speed of computation. The test was therefore *invalid* as a measure of arithmetic. Makers of tests are now supposed to determine experimentally to what extent a test does measure what it is supposed to measure. Since it is taken for granted that a test does satisfactorily gauge the ability it is alleged to measure, we shall not pursue this topic further here.

Aside from validity, then, tests vary in reliability and specificity.

A low degree of reliability is not necessarily to be deplored. Some tests, constructed for survey purposes, are of relatively low reliability because they are made brief in the interest of economy. It is necessary only that a test have sufficient reliability for the purpose it is to serve. The same is true of specificity. We may therefore consider next a few samples of the many particular purposes which achievement tests may serve.

THE USES OF ACHIEVEMENT TESTS

The purpose of an achievement test is to measure acquired ability or proficiency. The newer objective tests enable a teacher or investigator to do better than before all the things which he has ever tried to do with the results of examinations. They enable the teacher and investigator, furthermore, to do a number of useful things—such as to appraise achievement in terms of capacity, to compare fairly attainments of different classes, schools or cities, to diagnose detailed phases of ability—which they were unable to do at all before. Of these many practical uses we can describe only a few. In particular we shall mention the broad school survey of composite achievement and the detailed diagnosis of an individual pupil's ability in one subject.

The Educational Survey.—As a sample of a survey, results obtained from the combined use of a mental and educational test (by Pintner and Marshall) may be indicated. The tests used were the Pintner Non Language Group Intelligence Test, requiring about 30 minutes, and the Pintner Educational Achievement Test, requiring about the same time. Both tests were given to the pupils of 56 different schools. The scores from each test were then converted into the scores of the same scale. With the average scale score in intelligence and in general educational achievement at hand, the Accomplishment Quotients of the various schools could be computed. The following table indicates the wide range of A.Q.'s that were found.

Accomplishment Quotients	Number of Schools
120 and higher	4
110 to 119	9
100 to 109	12
90 to 99	15
80 to 89	9
70 to 79	7

These results show very clearly that some schools were doing much more for their pupils than others. They indicate the need of further inquiry concerning the causes of high and low proficiency. The school which is doing poorly with its pupil-material should improve its method. It may, in fact, profitably study the methods of the schools which are accomplishing the most with the pupil-material at hand.

Differences between school systems in efficiency are, of course, the result of variations in educative influences. Among possible educative influences would be many factors such as the administrative policy, the system of supervision, the character of the teaching staff, the methods of instruction, the length of the school day and year, the material equipment, apparatus, books, buildings, grounds and so on. From the scientific point of view the purpose of the survey is to determine the merits and defects of each factor which exerts an educative influence upon the abilities measured. The purpose of the survey from the immediate practical point of view is to enable the system studied to determine its own merits and defects and to put into effect any improvements that available scientific knowledge makes possible. A well conducted survey, therefore, is both a means of improving education in a local situation and of adding to the store of scientific knowledge.

Diagnosis of Individual Abilities.—A survey may vary all the way from a rough measure of general educational attainments and efficiency to a detailed analysis of all phases of ability in particular pupils. The following diagnosis of the reading abilities and difficulties of a particular pupil will suggest the character of the more detailed type of study that may now be conducted in several subjects. First are given the results of objective tests and later a discussion of these scores. (See table, p. 550.)

This pupil was, at the time of the test, about halfway through the fourth grade. Since his grade score in intelligence is 4.5, he is apparently graded to correspond closely to his intellectual level. He is of average mentality for his age; his I.Q. is 102.

TRACT MEASURED	GRADE SCORE	AGE SCORE	EA ÷ CA	EA ÷ MA
1. Chronological Age	4.41	10.2	....	....
2. Intelligence, Stanford-Binet	4.5	10.4	1.02	....
3. Reading, Difficulty of Comprehension (Thorndike-McCall)	4.2	10.0	.98	.96
4. Reading Rate, Gates General Impression	2.5	8.0	.78	.77
5. Reading Rate, Gates Predict Outcome	2.7	8.2	.80	.79
6. Reading Rate, Gates Precise Directions	2.7	8.2	.80	.79
7. Reading Rate, Gates Details	2.0	7.8	.76	.75
8. Reading Rate, Average of 4, 5, 6, 7	2.8	8.3	.81	.80
9. Reading Accuracy, Average of 4, 5, 6, 7	5.1	10.9	1.07	1.05
10. Average Silent Reading, Tests 3, 8 and 9	3.9	9.7	.95	.93
11. Oral Reading, Gray's Composite	4.5	10.4	1.02	1.00
12. Gates Word Pronunciation, Difficulty	4.6	10.6	1.04	1.02
13. Gates Phonetic Ability Tests	5.9	11.8	1.15	1.13

In most phases of reading ability this boy is below the average of pupils of the same mentality and age. The best statement of his reading ability in general is item 10, which is the average of the scores from several tests of silent reading. This composite Reading Age is 9.7 years or 95 per cent of the pupil's chronological age and 93 per cent of his mental age. The last figure is the Accomplishment Quotient. In general silent-reading ability, this boy is about a half-grade retarded; his reading grade, to be exact, is 3.9 instead of 4.5 to which his Mental Age corresponds.

In oral reading, as measured by Gray's Oral, this pupil is exactly average for his Mental Age; his oral reading Accomplishment Quotient is therefore 1.00. The deficiency then is primarily in silent reading.

Note that this pupil's ability is not the same in all phases of silent reading. Assuming that all the records are accurate (which they are not exactly) it appears that this pupil excels in *accuracy* (item 9). He is only slightly below the norm in *difficulty* or *altitude* of comprehension (item 3). He is lowest in *speed* of reading (item 8). He is a pupil who comprehends at a level normal for his capacity, who understands what he reads with better than average accuracy but with less than average speed. He is a "slow but thorough" type of reader. Tests 4, 5, 6 and 7 show that he is slow in all four types of silent reading tested. Whatever the material or purpose for reading, the reading process is slow and laborious. For example, he cannot skim rapidly over the material when he is asked merely to "get the general impression" from it.

Further tests were given to determine the cause of this pupil's slow, labored reading. The Gates Phonetic tests (Test 13) showed for a pupil of this grade an unusual familiarity with minute phonograms and ability to translate letter combinations like *in*, *str*, etc., into sounds. Observing the pupil in the Word Pronunciation Test and the Oral Reading Test, it was found that he had been overtrained in the use of the phonetic method. He was so dependent upon it that he had to see each word quite distinctly and in detail before recognizing it. The requirement of seeing each word quite distinctly, instead of quite superficially as most of us do in rapid reading, slowed down his rate and interfered somewhat with his comprehension. The interference with comprehension, caused him to slow down still more and to study diligently to get the thought correctly. The result was slow, but accurate, comprehension of the thought.

The pupil did relatively well in comprehension in the *difficulty* tests (Test 3) in which he had plenty of time. He also did well in oral reading and pronunciation tests in which he was merely required to say the words but not to comprehend the thought.

This pupil was given remedial instruction designed precisely to correct the defects and strengthen the particular weakness revealed. A mere increase in instruction or practice in reading in general would have been an unsatisfactory, possibly a futile, remedy. The result of the instruction adapted to his particular needs was that in a relatively short time the pupil developed better than average facility without an unwise sacrifice of his admirable accuracy and fullness of comprehension.

In general, the purpose of the diagnostic tests is to reveal particular strengths and weaknesses in the skills fundamental to such a complex ability as reading. Such a diagnosis makes it possible to preserve the good habits and to remove the weak ones and substitute desirable ones in their places.

We should add that the more objectively such a diagnosis can be made the better. In the examination just reported it may have been noted that the examiner resorted to some subjective judgments based upon observation of the pupil's performances in certain tests as well as upon the objective scores. Few highly detailed diagnoses of educational abilities can be made at present by wholly objective methods. In this respect the educational diagnostician is in the same situation as the medical expert. The latter uses the thermometer, chemical tests, blood counts, and graphic records of heart action and other objective tests as far as possible but he also has to rely considerably upon his judgment sharpened by experience. The aims and methods of the educational, psychological and medical diagnosticians are essentially the same.

SPECIAL APTITUDES AND INAPTITUDES

Variations Shown in Proficiency Profiles.—The measurements just given reveal considerable variations in standard scores among the tests of various reading and related abilities. This pupil, in other words, shows some degree of specialization in ability. Had tests in other subjects been given to him, further variations in strengths and weaknesses might have been shown. Indeed, it is usual to find that even when different individuals are of the same race, sex, age, intelligence and general training, abilities are not uniform but varied in magnitude. Pupils whose scholastic abilities are, on the whole, about equal show particular high and low degrees of proficiency in particular subjects or phases of a subject. These variations

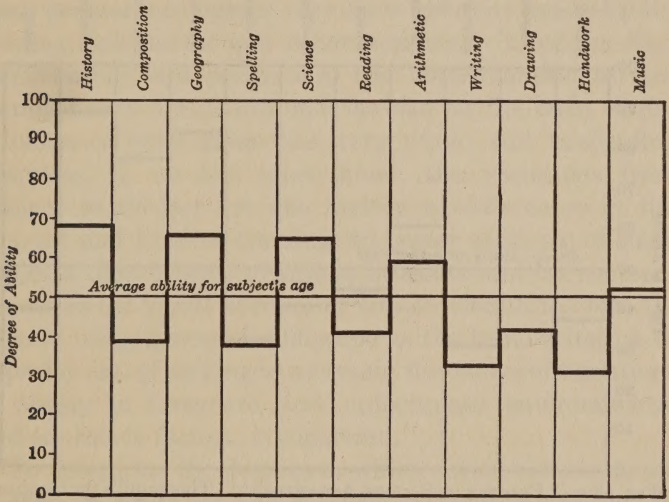

Fig. 47.—A Proficiency Profile of School Attainments. The scale varies by steps from the poorest to the best achievements found among a large number of pupils of the same age. The horizontal line at 50 indicates the average ability in each test. The ability of the pupil is shown by the short line under the name of each test. This pupil's profile shows about the typical degree of deviation. He is strongest in history, geography, science and arithmetic, slightly weak in the linguistic arts, composition, spelling and reading, average in music and weakest in the mechanical arts of writing, drawing and handwork.

may be shown most clearly in a graphic form which may be called a Proficiency Profile. Figures 47 and 48 picture different individual cases. The variations obtained with educational tests are considerable in the average case and in extreme instances an individual may reveal wide departures from his own average proficiency. Specialization in achievement is apparent. How is it to be explained?

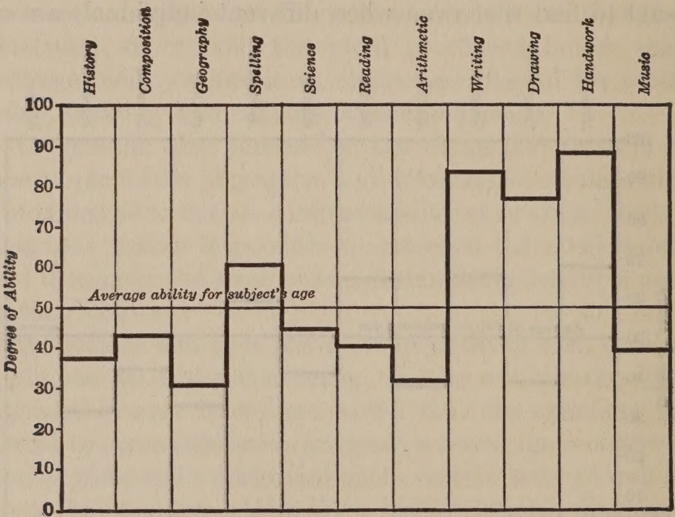

Fig. 48.—A Profile of School Attainments. This pupil's profile shows somewhat greater variations than the one pictured in Figure 47. This pupil is, on the whole, inferior to the average in the abstract and linguistic subjects and in music, but superior in the manual arts of writing, drawing and handwork. Compare with Figure 47.

Explanations of Variations in Educational Achievement.—It is widely agreed that variations shown in such Proficiency Profiles are due in part to each of three causes: (1) errors in measurements; (2) differential effects of educative influences upon the learning of the abilities tested and (3) differences in native aptitude for the various subjects. It is of considerable importance to know to what extent each of these factors is responsible for irregularities in attainment among scholastic abilities. Especially it is important to know how much the obtained variations are due to educative influences on the one hand and to native capacities on the other. If marked irregularities are due to variations in native capacity such that pupils of the same general intelligence may have different aptitudes for reading, arithmetic and other activities, it follows that classification and promotion, the determination of Accomplishment Quotients and the like on the basis of the intelligence tests alone are very crude and misleading practices. If, on the other hand, the variations from subject to subject are due mainly to differences in the amount and kind of training, to better teaching of some subjects than others, to keener interests and better techniques as the result of more or less accidental factors, the plan of using general intelligence as the basal criterion of capacity and of seeking to ascertain the causes of variations in ability in fortunate and unfortunate environmental and educative factors, is suggested.

To determine the degrees to which actual achievements in various activities and subjects pursued in and out of school are due to capacities other than general intelligence, on the one hand, and to environmental influences, on the other, is very difficult. It is difficult because it is nearly impossible to detect and appraise every possible variation in environment and experience. Although the results are still far from conclusive, much research has been done on this problem. We shall offer here a brief statement of the situation as it appears at present with the understanding that it is tentative and subject to revision.

A Tentative List of Special Capacities or Aptitudes.— The evidence now available indicates that there are probably several groups of capacities which are sufficiently different from that group measured by such an intelligence test as the Stanford-Binet to merit the development and use of capacity tests for them. The most probable types of such special capacities are the following:

(1) *Musical Capacities*, such as those required for achievement in playing, singing and otherwise producing music and in appreciating, judging and otherwise discriminating music. The Seashore Tests of Musical Talent are the best-known instruments for measuring such capacities.

(2) *Artistic Capacities*, essential to discriminative and creative activity in painting, drawing, modeling, architecture, dressmaking, interior and exterior decorating. Tests recently developed by Meier, Christensen, Speer, and others mark a beginning in this field.

(3) *Mechanical Capacities*, essential to discriminative, constructive and manipulative activities in dealing with tools, apparatus, machines, etc., in the mechanical arts and industries. The Stenquist Tests of Mechanical Aptitude represent one type of measurement of such capacities.

(4) *Locomotor Capacities*, which perhaps function in most pure form in athletics, gymnastics and sports, but which enter into other skills which require skillful management of bodily action. The Rogers Physical Capacity Tests and the Brace Motor Ability Tests are examples of tests of locomotor capacities.

(5) *Social Capacities*, essential to understanding and influencing other people as in the work of the teacher, minister, salesman, military officer, physician, politician, lawyer, industrial manager and so on. For measuring social capacities many tests have been developed, but none is as yet very comprehensive or outstanding.

(6) *Possible but Doubtful Groups of Special Capacities.* Here will be included such groups of aptitudes as those for mathematics, reading, literary appreciation and composi-

tion, spelling and many others, to be discussed presently.

It will not be possible in this book to describe each of these groups of capacities or the various tests designed to measure them or the evidence which suggests their validity. We shall merely briefly indicate the nature of one of them as representative of the first five groups and give a brief statement of our attitude toward those mentioned in the sixth group. The outstanding achievement in the development of capacity tests has been the work of Seashore upon musical talent.

Seashore's Tests of Musical Talent; a Sample of the Measurement of a Group of Special Aptitudes.—Like other tests of this type, the Seashore series is an aggregate of many tests. It includes measures for many particular abilities which have been found in experimental and analytic studies, to be involved in musical talent. In brief outline the tests are:

I. Tests of musical sensitivity
    A. Simple forms of impression
        1. Sense of pitch
        2. Sense of intensity
        3. Sense of time
        4. Sense of extensity
    B. Complex forms of appreciation
        1. Sense of rhythm
        2. Sense of timbre
        3. Sense of consonance
        4. Sense of volume
II. Tests of native capacity for acquiring skill in motor production of tones vocal, instrumental or both
        1. Control of pitch
        2. Control of intensity
        3. Control of time
        4. Control of rhythm
        5. Control of timbre
        6. Control of volume

III. Tests of musical memory and imagination
    1. Auditory imagery
    2. Motor imagery
    3. Creative imagination
    4. Memory span
    5. Learning ability
IV. Tests of musical intellect
    1. Musical free association
    2. Musical power of reflection
V. Tests of musical feeling
    1. Musical taste
    2. Emotional reaction to music
    3. Emotional self-expression in music

Since all of these abilities are involved in music, it follows that aptitude for music is not to be conceived as a unit trait or a single and simple capacity. On the contrary it is an aggregate of many. Excellence in one, coupled with deficiencies in others, would not suffice for achievement. Some single deficiencies such as the capacity to discriminate pitch within certain limits—a capacity that is usually native and unimprovable—would, on the other hand, make progress in certain phases of musical ability impossible however optimum the capacities in other respects. The apt individual is the one who approaches an optimum degree of native endowment in all. A final appraisement of musical aptitude would, consequently, be based on a consideration of many constituent capacities, each weighted in accordance with its importance.

It is probable that all of the special group aptitudes listed above are of this general character. Each is not a single power or faculty but a group or composite of many more minute capacities. It is true, furthermore, that the five groups of capacities, listed above, together with intelligence, which would make a sixth, are not *wholly* distinct. Elements from each group are involved in others. Thus, as we observed earlier, intelligence is in a considerable degree involved in ability to influence other people and to do various jobs in the mechanical field. Similarly there is an overlap of mechanical and artistic capacities as in sculpture or painting; of mechanical and locomotor talents as in operating a steam shovel. In many particular tasks some degree of all of the six group capacities are involved;

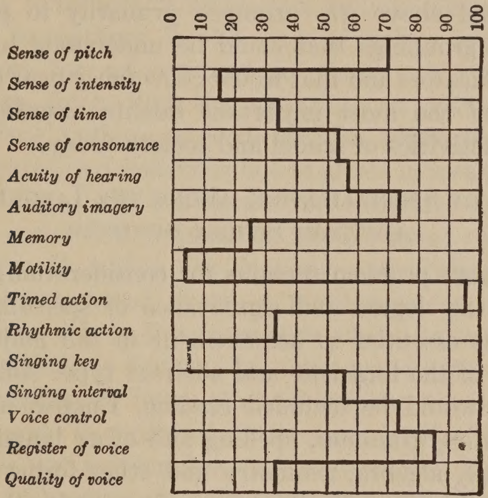

FIG. 49.—A GRAPHIC REPRESENTATION OF THE ABILITIES OF MR. GRAY IN THE SEASHORE TESTS OF MUSICAL TALENT. Scores range from 0 to 100 as shown by the figures in the top line. The tests are designated by titles on the left. Professor Seashore's summary of this case is as follows: "Mr. Gray has a fairly good sense of pitch, very poor sense of intensity, and poor sense of time. His sense of consonance is below average. His acuity of hearing is exceedingly fine. He has good tonal imagery, but decidedly inferior tonal memory. His general motility is superior and his timed action is good, but his rhythmic action is poor. He sings in fairly true pitch and reproduces intervals fairly well. He has a very wide register of voice but poor quality. In general, Mr. Gray is a fair type of what is popularly called 'average' musical ability, that is, he ranks high in some talents and low in others. He has had little musical education, but possesses a decidedly artistic type of mind and lives much in musical feeling and vital artistic appreciation." (From C. E. Seashore's *The Psychology of Musical Talent*, Silver, Burdett & Company, by permission.)

in almost every activity several of the groupings are engaged in various degrees. After all, the selection of the groups is largely a matter of practical convenience. The list offered above was arranged primarily to provide a series of groupings that could be understood by professional educators and that would come fairly near to including all of the most important talents essential in the typical activities of school and society today.

DEGREE OF SPECIALIZATION AMONG THE LINGUISTIC AND ABSTRACT SCHOOL SUBJECTS

One more problem remains for consideration; namely, that of the degree and significance of specialization of capacities essential to achievement in the major school subjects of the linguistic and abstract type. Among such subjects would be included reading, English usage and composition, grammar, spelling and other language arts; arithmetic, algebra, geometry and other forms of mathematics; history, geography, civics and other social sciences; physics, chemistry and the physical sciences; nature study, physiology and other biological sciences, and so on. The main problem here is really this: If such measures of general intelligence as the Binet tests were perfectly valid and accurate, would they indicate quite closely native aptitude for these various subjects? Or is it true that individuals, found to be equal in intelligence when measured perfectly, would still show differences in native aptitude for each of such specific lines as reading, English composition, mathematics, history, physics, and so on?

An Opinion concerning Specialization in These Subjects.—The evidence is not conclusive and students of this problem therefore hold different opinions. During the past ten years the present author has become gradually more disposed to believe that there is some, but relatively little, specialization of native capacities for these subjects. With a few qualifications to be made presently, it appears to him that those capacities which we have incorporated under the term *general intelligence* include almost everything of importance in the way of native intellectual endowment for achievement in these subjects. He is inclined to think that the variations in ability found among these various subjects are due primarily not to further specialized aptitudes but to errors in measurement and to variations in experience and educative influences of many sorts. The implication of this point of view is chiefly this: If, within the linguistic and abstract group of subjects suggested above, a pupil does far better in some than in others, the cause is chiefly to be sought and found in educative factors—in amount and kind of study and instruction, in fortunate and unfortunate influences upon interest, in types of motivation, in the effects of missing or not missing lessons, in stumbling luckily on excellent techniques in some cases and unluckily on inhibitory reactions in another and so on. The cause is to be sought in such extrinsic factors rather than in specialized native aptitudes and inaptitudes. The implication, further, is that wide variations in achievement among these activities should be diagnosed and treated according to the character of the causes and not passed off as "natural peculiarities" or specializations of aptitude.

Nature of Evidence for the Opinion that Specialization among These Subjects Is Extrinsic Rather than Intrinsic.—The evidence behind this opinion that specialization among the major linguistic and abstract subjects is predominantly the result of *extrinsic* factors, is difficult to summarize. In general, it is based upon the results of extensive studies of the acquired habits, attitudes and techniques, on the one hand, and of many sorts of constitutional factors on the other in the case of pupils who are in certain subjects either far below or far above the average scholastic ability. These diagnoses are most convincing when followed by remedial instruction designed to show whether the abilities especially deficient could be remedied by educative factors. Perhaps the best way of explaining the nature of these studies is to illustrate one.

A Sample Study of "Disability" in Reading.—This is the case of a boy who earned a superior intelligence on the Binet Scale—an I.Q. of 116 to be exact—but who had been unable to learn to read during two and a half years of schooling. When first tested in October 1923, at the age of 8.5 years, his high I.Q. and his almost total "disability" in reading were verified. He had been diagnosed previously as being a case of "congenital word blindness"—a term much used by physicians and others to designate the most extreme form of native inaptitude for reading or spelling. The results of the diagnosis of this boy are roughly indicated in the following excerpts from the note sent to his teacher and school principal:

> "——has been examined for his difficulty in reading with the following results:
>
> "His mental age and Intelligence Quotient are high; his failure in reading cannot possibly be attributed to dullness.
>
> "In a series of tests of visual acuity and speed and accuracy of visual perception of small printed items of various sorts,—secures high scores for his age in all tests except those composed of words. This means that he has no organic defects of vision or of capacity for visual perception that could interfere with his reading. The low scores in the word perception tests must be due to other defects.
>
> "We have tested ——'s hearing and found it normal. We have also examined his skill in discriminating and retaining a series of complex word sounds long enough to reproduce them. He made a perfect score on this test, which means that auditory defects are not present.

"——'s memory span or 'immediate memory' for visual items and for digits, letters and nonsense words presented orally was tested and no deficiencies in these capacities appeared. We also gave —— two tests for learning ability that resemble the task of learning a series of words (the 'words' are really made up of an artificial alphabet) and found that he could learn these words rather better than the average person for his age both when the 'meaning' of the words were given visually by a picture or orally in the form of a familiar word. These results indicate that —— really possesses the fundamental mental machinery for learning printed words; at least words of a 'foreign' language. The doctor's suggestion that —— is subject to 'word-blindness' and the parents' idea that he has a hidden brain defect caused by a fall are, we believe, erroneous. The trouble is probably entirely one of the faulty methods of learning English words. The fact that he could learn our artificial or 'foreign' words is strong evidence for this belief.

"The nature of ——'s difficulties could be detected in some measure by observing the way he works when he tries to learn or to read familiar words. He makes so many gross errors such as *what* for *was*, *turn* for *return*, *this* for *sit*, as well as so many more common ones such as *they* for *there*, *was* for *were*, etc., that he rarely gets any sense from what he is reading. Yet, he reads very rapidly, acting the while as if the jargon really meant something to him.

"We tried out —— for his ability to break a word up into parts such as syllables and phonograms, to spell simple words in small parts, to recognize and also sound single letters, phonograms like *br*, *in*, *up*, etc., syllables like *ber*, *ought*, etc. While he showed some ability to translate some of these elements into sounds, he has almost no ability to recognize these word elements in whole words and almost no ability to break a word up into its elements. He appears to give a word a quick superficial glance in which he gets only a vague impression. He lacks the technique of seeing a word acutely, of seeing not only its vague outline but also its distinctive parts. He lacks skill also in analyzing a word into its elements. (Incidentally, he makes errors in reading the alphabet; *b* and *d*, *p* and *q* were confused, and he hesitated on *n*, *r* and other letters.)"

The remainder of the letter was devoted to recommendations for remedial instruction. A competent teacher put these suggestions into effect with the result that, after a period of confusion, the pupil began to improve with remarkable speed. The following are a few of the records subsequently taken.

Date of Examination	Pupil's Age	Reading Age	Reading Quotient	Intell. Quotient	Accomplishment Quotient
Oct. 21, 1923	8.5	6.4	.75	116	65
Jan. 10, 1924	8.7	8.3	.95	116	82
May 1, 1925	10.1	12.0	1.19	116	103
Dec. 9, 1926	11.7	15.2	1.30	116	112

Here, then, is a pupil whose inaptitude for reading, despite high I.Q. appeared to be so great as to make it almost impossible for him to learn at all. The diagnosis revealed no deficiencies in any of the constitutional factors examined but extraordinarily poor techniques acquired in the initial stages of learning and left undiscovered and uncorrected. After they were detected, the inappropriate habits were rapidly supplanted by serviceable ones as the result of sagacity guidance by the teacher. Once on the right track this pupil developed proficiency in reading so rapidly that in three years his reading age excelled his chronological age by 12 per cent. If special native aptitude is to be held solely accountable for the scores, this pupil would first have been characterized as having a marked special inaptitude, and three years later as possessing a marked talent for reading.

The case just described is an unusual one, of course. No sensible person would justify a theory on a few such cases. The writer's opinion, stated above, is based on the belief that similar studies in reading (by Gray and others); in arithmetic (by Buswell and John, Knight and others);

in spelling (by Horn, A. Watson, and others); in algebra (by Symonds) and in other subjects have showed similar trends. The prevalence of cases showing in various degrees the characteristics of the one just cited tends greatly to reduce correlations of abilities in particular subjects with intelligence and to produce irregular proficiency profiles. The writer believes extrinsic factors are mainly responsible for the variations among these broad linguistic and abstract subjects.

Other Factors Which May Influence Achievement.—The constitutional factors reported in the case of reading indicate the nature of certain other causes of variations in achievement. Thus seriously defective vision of hearing, or vocal-motor, or eye motor control might handicap a child equal in intelligence to others whose sensory and motor apparatus were normal. These defects might interfere with reading more than with arithmetic and if so, cause some degree of irregularity. Diagnosis should, therefore, take into account all organs and elementary functions concerned.

Finally, efficiency as revealed by the Accomplishment Quotient may be influenced by personal characteristics which are commonly classified as temperamental, volitional, emotional and other types of *personality* traits. Among pupils of the same intelligence and subject to equally fortunate educative influences, variations in general efficiency, at least, may result from differences in temperament, character and personality. The last chapter will be devoted to a discussion of these traits.

QUESTIONS AND EXERCISES

1. What is the difference between a *test* and a *standardized test?*
2. What is the difference between a *raw score* and a *scale score?*
3. Summarize the advantages of the three types of scales mentioned in the text.

4. What kind of a test is it when you measure the speed of running 100 yards? How would you make an age scale for this test? A grade scale? A variability scale? Which would be most useful?

5. What kind of a test is used to measure ability in the high jump?

6. John Doe is 10.2 years old; his Mental Age is 10.4 years; his Reading Age 9.4; his Arithmetic Age 10.6; his Spelling Age 10.0; his History Age 10.2; his Language-Usage Age 10.3. Compute the I.Q., the Educational Quotients for each subject and the Accomplishment Quotients for each subject. Then compute his general Educational Age and Accomplishment Quotient. Finally, write out a report of John's educational status and make any recommendations you may think advisable concerning his treatment in school.

7. What is meant by the reliability, the validity and specificity of a test? Is it all right for a survey test to be fairly low in each of these respects?

8. What were the several types of special aptitude or capacity mentioned in the test? To what uses could good tests of each of these capacities be put?

9. What is your own opinion concerning the question whether intelligence is the main component of capacity in the linguistic and abstract subjects?

10. Which of the several capacities would probably enter into ability to: (a) play basketball; (b) golf; (c) drive an airplane; (d) sell life insurance; (e) manage an automobile repair shop; (f) succeed as an electrical engineer?

11. What unfortunate results may come from assuming that the age or grade scales are goals or ideal levels of attainment?

12. What are some of the advantages of using objective tests in such subjects as geography, history or psychology? What are possible disadvantages?

13. Suggest various uses that could be made of the Accomplishment-Quotient technique as a means of motivating achievement.

14. Elaborate the comparison of a diagnosis of difficulty in reading or spelling with the diagnosis of physical illness. In what does remedial treatment for the poor reader resemble remedial treatment for the person physically ill?

15. Prepare an affirmative or negative argument for this statement: Every school should have as competent a person to diagnose mental and educational difficulties and ills as it has to diagnose physical difficulties and ills.

16. How can a test of manipulating mechanical implements be a measure of mechanical aptitude or capacity?

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CHAPTER XVII

PERSONALITY

Definition of the Term.—The dictionary defines *personality* as "that which constitutes a person." Asking a student what personality means, I am told: "Well, personality means the way a person strikes you as attractive or unattractive and so on." The two statements may be combined by defining personality as all those traits which have a social significance, which influence or "strike" other people. This is a satisfactory preliminary definition since it appears that few, if any, observable human traits are utterly without social significance. Probably all components of a person's make-up influence in some degree that which we call that individual's personality. It is probable also that many, or even all components of a person's make-up influence in some degree his own achievement, his own happiness, his own morality. This statement is in harmony with the fact repeatedly mentioned that a person is a more or less fully integrated organism. Ordinarily he reacts as a whole, rather than in quite isolated units. He works as a whole in arithmetic. It is Mr. Smith who addresses the audience or cracks jokes to amuse the girls, and not some isolated part of Mr. Smith. In treating the topic, personality, we shall consider carefully the way all of the components of Mr. Smith are organized and integrated or coördinated. Mr. Smith represents not only a series of components but a form of organization. A personality is a pattern or integration. It is something more than a list of elements quite as an automobile, fully assembled, is something more than a list of parts. What a human organism or an automobile will do depends upon the assembly, upon the coördination and integration of parts. To understand an automobile fully, however, you need to know something about the parts as well as how they are put together and how they work together. Since this is true of the personality, let us stop a moment to survey its components before seeing how they are combined.

CLASSIFICATION AND MEASUREMENT OF PERSONALITY TRAITS

If you listen to descriptions of people, or read biographical or fictional characterizations, or study school report cards or application blanks used in business, you will be struck by the diversity of words used to indicate important human traits and by the variety of characteristics selected. If you observe the classifications of personality traits used by scientific workers, such as psychologists, you will also find different terms. Thus one author groups the components of personality under three terms, physical appearance, social attitudes and intelligence; another under intellect, character and temperament; another under five terms, intelligence, emotionality, sociability, volition and morality.

Personality "Traits" Are Arbitrary Groupings of Facts.—It is important to understand, first, that every physical and mental characteristic and every reaction tendency of the organism is a component of the personality. It is important to realize, secondly, that the classification of personality into two or three or any other number of "traits" is an entirely arbitrary matter done merely for convenience in discussion. Authors resort to the classification of facts concerning human characteristics and reactions under terms that seem to them suitable chiefly because it is impossible to describe all of the facts in a single chapter. Titles serve to assist recall of numerous related facts. A statement that the personality consists of intelligence, temperament, character and sociability should therefore not be taken to mean that these words refer to unitary powers or faculties. We observed good reasons in the chapter on the Transfer of Training for rejecting such general faculties or characters. Such statements mean merely that an author has arbitrarily grouped the whole series of human characteristics and reaction tendencies under several words. Different words and different numbers and types of groupings may be used by different authors as a means of classifying the same characteristics and facts. It is only necessary that the list be inclusive and that it be used with reasonable consistency. With these cautions against thinking of a term which refers to a class as a title of a unitary character, power or faculty, we may proceed to offer a scheme of classification with some remarks about the measurement of the characteristics included in each.

The following classification is an arbitrary means of summarizing the characteristics and reaction tendencies previously presented in this book under the same or other titles. The list is made relatively long in order to be inclusive. It is subject to a good deal of overlapping; elements under one title appear again, usually with different degrees of importance, under others.

(1) *Physical Traits*, such as height, weight, build, appearance, facial expression, health, stamina, efficiency of sense organs and various bodily functions.

(2) *Mental Traits*, intelligence, as a measure of general mental endowment, and more specific forms of mental activity as in memorizing, perceiving, reasoning, imagining.

(3) *Special Capacities*, such as *musical, artistic, mechanical, locomotor* and *social* aptitudes. As explained in the preceding chapter, these capacities include groupings of many more minute physical, sensory, motor and mental aptitudes which appear in different combinations. They represent clusters made with reference to the fields of human activity.

(4) *Acquired Interest, Knowledge and Technical Skill.*—This grouping is made because a person's capacity is to be distinguished from his acquired interests, information and skill. A personality is in a large measure a reflection of what one has learned to do, what one knows and what one is interested in. Persons of nearly identical capacities might have very different personalities as the result of the ways in which the capacities were employed.

(5) *Temperament.*—By temperament we refer primarily to all phases of emotional tendencies and behavior. Under this term would be included facts given in our discussions of emotions and nervous stability. Whether a person is excitable or calm, cheerful or pessimistic, pleasant or irascible, courageous or timid, are questions related to aspects of temperament.

(6) *Volition.*—Under volition would be included many characteristics relating to voluntary control of all forms of action. Here we would seek to ascertain the typical forms of adjustment, such as were mentioned in Chapter VII, and the degree to which action is initiated and sustained by acquired ideals and purposes. Is this person active or lethargic, is he positive or negative, determined, strong-minded, uncertain, vacillating, pliable, weak? Has he the "strength of will" to stand discomfort, deprivations, boredom, misfortune? Has he the ability to adopt wholesome and constructive forms of adjustment and to stick tenaciously to his purposes or is he submissive to circum-

stances, and a slave to habits of introversion, rationalization, sour-graping and indolence? These and many related reactions tendencies may be grouped under volition.

(7) *Character.*—Under character we may group those reaction tendencies toward situations which involve moral, ethical and religious codes and other socially approved standards of conduct. Here we would inquire, "Is this person disposed to be honest, decent, humane, unselfish, law-abiding?" What are his social and ethical ideals and purposes and how well are they put into effect?

Although these groups of traits are quite arbitrary and overlap greatly, they could be made a basis of classification for practical purposes. Adequately to appraise such phases of a personality and to understand them better, we need objective measures of them. In previous chapters we have considered as far as we can in this volume the measurement of physical and mental traits, special capacities and acquired abilities. Let us now discuss briefly the possibilities of testing the other phases of personality designated as temperamental, volitional and character traits.

TESTS OF TEMPERAMENTAL, VOLITIONAL AND CHARACTER TRAITS

Difficulties in Measuring Personality Traits.—Tests of the simpler physical traits and functions, of intelligence and certain special aptitudes, of various mental processes and scholastic and acquired abilities have been developed more extensively than measures of the various character, social, emotional and volitional traits. That the task of measuring these aspects of the personality is not as yet far advanced is substantial evidence not of indifference but of the complexity and difficulty of the tasks involved.

The fact that character or temperament or volition is not a single, unitary trait but merely a term for a large number of particular reaction tendencies is a fact that makes it appear reasonable to measure behavior directly. The same fact suggests, however, a source of difficulty. The difficulty is that each general characteristic, such as temperament or volition, includes many specific reaction tendencies. Since these traits are arbitrary classifications of particular reaction tendencies, to measure any one group requires a sampling of a considerable number of related activities.

This being the case it was soon found that no single test was sufficient to reveal one's character, or even one's honesty; one's temperament, or even his tendency to anger; one's volition, or even his suggestibility. To gauge any one trait under any one category, it is necessary to test the individual's reactions in several different situations. The problem is, however, not unlike that encountered in testing educational achievement or intelligence. It is necessary to take a number of good samples of each type of reaction and combine, or average them. If the individual tests are properly selected, the resulting composite score will be a useful indication of some phase of the personality just as the score obtained from several scholastic tests is a practically serviceable index of general educational attainments. And likewise, just as it was found that certain tests of acquired abilities such as those in the Binet tests could be selected so as to yield a useful measure of intellectual capacity, so it may be possible to find groups of tests that will reveal native predispositions in character, volition and temperament.

In this connection, we should recall the general principle stated in Chapter XV; namely, that tests which measure acquired reactions may reveal differences in native capacities or predispositions when all factors influencing the development of the acquired reactions, among a group of individuals of the same age, have been equally potent. To discover for what persons and under what conditions any tests of conduct will reveal constitutional capacities and tendencies is always a difficult problem and for most of the personality tests now available the facts are not as fully known as they are for tests of intelligence. It will be impossible in this book to do more than characterize roughly several types of methods of measuring acquired forms of conduct.

Many hundreds of studies have been made in an endeavor to appraise the temperamental, volitional and character traits indirectly by measuring physical, chemical and physiological characteristics of the organism. Various relations of height and weight; different shapes and proportions of the body and head; facial features; the chemical compositions of the blood, urine and saliva; the size of glands; various aspects of the pulse, blood pressure, circulation, breathing and many other similar functions have been measured in the hope of discovering physical, chemical or physiological traits closely correlated with aspects of personality. On the whole, these methods of measurement have been found wanting. Although the most promising of these lines of attack, the measurement of chemical components of the body which we mentioned in discussing the glands, is not yet far advanced, psychologists have largely adopted the method of appraising the personality by measuring behavior itself.

Types of Reactions Measured.—Most of the hundreds of tests of behavior which have been constructed may be classified under one of the following four types:

(1) Reactions to words.
(2) Reactions to situations described, pictured or otherwise represented.

(3) Reactions to laboratory and artificial situations.
(4) Reactions to typical, lifelike situations.

Reactions to Words: "Association Tests."—Among the devices for appraising various personality traits, association tests were early devised. In the association test, the stimulus is a word presented visually or orally. There are two types, the *free* and the *controlled* association tests. In using the free association method, the examiner presents the subject with a stimulus word selected to initiate a flow of ideas in some phase of experience. Thus such words as *money*, *women*, *marriage*, *blood*, *enemies*, *danger*, *family*, are used to arouse associated ideas. The subject is expected to permit his thoughts to rove freely and to report what occurs to him. The nature of the ideas which occur, the freedom of the associations, and the character of the blockings, hesitations or shifts of thought may furnish the examiner with clues to the subject's "complexes," or emotionally tinged ideas, and thereby indicate the nature of his satisfactory and unsatisfactory adjustments; of his disposition, whether pessimistic or optimistic, retiring or aggressive; of his fears and satisfactions, and of his types of thinking, whether systematic and free, or disjointed and halting. Recently, tests in which the associated responses are more thoroughly controlled and are comparable with standards have found greater favor. For example, two lists of one hundred words each have been given, a word at a time, to a large number of adults (by Kent and Rosanoff) and to children (by Woodrow and Lowell), and the first word responded to each stimulus word recorded. For each word is thus available a table showing the relative frequency of each response. By comparison with these tables, unusual responses can be detected and their significance later discovered. When responses which are indicative of various mental, temperamental and volitional attitudes have been determined, the association test becomes an instrument for appraising personality traits. By study of associative tendencies, hesitations, changes and other peculiarities in response, emotionally toned ideas, such as guilt, may also often be detected. Frequently, the accompanying changes in heart action, blood pressure, glandular activity and other physiological functions, determined by means of appropriate instruments, serve as supplementary evidence.

Many other varieties of word-association tests are now being studied. Thus far, the association method has been of demonstrable value only when utilized by experts for certain limited purposes, mainly to make a preliminary survey of the mental, temperamental, moral and volitional dispositions of a person and to uncover emotionally tinged ideas or experiences.

Reactions to Described Situations.—A situation portrayed by a picture or drawing, or described in printed or spoken words may be used to elicit a response as the basis of a test. For example, a subject may be asked to describe his feelings or moral judgments aroused by pictures of a man beating a horse or giving alms to a beggar, etc. More frequently the situation is described in the form of a statement, question or problem, and the subject is asked to indicate some type of response, as in the following tests of social and moral insight. The subject is asked to read the problem and check the solution he considers best.

If someone asks to borrow your pencil:
(a) Tell him it is broken.
(b) Tell him that you have just lost it.
(c) Tell him that you don't want to loan it.
(d) Let him take it.

If you see a classmate cheating during an examination:
(a) Say nothing to anyone.
(b) Explain to him that it is wrong and warn him.
(c) Report it to the teacher.
(d) Say nothing, but try to cheat, yourself.

Out of many such "pencil and paper" tests of knowledge concerning moral, social, emotional and volitional issues has developed the fact that knowledge of what is the proper thing to do is no guarantee that a person will or can do it. One may know the best thing to do but be unable to do it or actually prefer not to do it. Although knowledge is not equivalent to power, it is nevertheless usually an essential prerequisite. Tests of knowledge must be supplemented, however, by measures which reveal actual conduct.

Various tests have taken the form of questions concerning not what is the proper thing to do, but what one does do or has done in the past. One of the most useful of this type of test is the Psychoneurotic Questionnaire developed by Woodworth for use with American soldiers during the late war. The questionnaire comprised a list of 116 questions concerning various habits of thought, emotional response, social adjustments and volitional control. It was used primarily to detect symptoms of unfavorable or psychoneurotic tendencies among recruits. The following are sample questions:

1. Do you usually feel well and strong?............... Yes No
10. Do ideas run through your head so you cannot sleep? Yes No
20. Do you have queer, unpleasant feelings in any part of the body?.................................... Yes No
30. Did you have a happy childhood?.................. Yes No
40. Have your employers generally treated you right?... Yes No
50. Are you ever bothered by the feeling that things are not real?...................................... Yes No
71. Can you do good work while people are looking on?.. Yes No
98. Do your feelings keep changing from happy to sad and from sad to happy without reason?................ Yes No

108. Have you ever been afraid of going insane?......... Yes No
114. Can you stand the sight of blood?.................. Yes No

The average number of symptoms or positive responses out of the possible 116 was, for white recruits in general, 10; for college students, 10; for the psychoneurotic soldiers encountered during recruiting, from 30 to 40. This type of test has since been arranged for use with school children and other groups. For a preliminary appraisal of emotional, temperamental, social and volitional dispositions, some of the tests have proved to be clearly useful. Further work promises to make more definite appraisals possible.

Reactions to Laboratory or Artificial Situations.—A great amount of ingenuity has been displayed in arranging artificial laboratory situations to which a person reacts under standardized conditions. A clue to a person's social reactions has been obtained by recording the responses to remarks made or activities carried out by the examiner and other confederates. Emotional tendencies have been revealed by observing the conduct which follows various acts and remarks of the examiner or which are produced by exposing the subject to what are apparently dangerous, repulsive, cruel or exciting objects or events (by Landis and others). One of the best-known series of tests of this general type is the so-called Will-Temperament Tests devised by Downey.

The Downey tests were designed to measure a series of volitional tendencies although, as the title indicates, it is difficult to distinguish volitional from temperamental traits. The test situations are carefully set up and controlled. The series includes twelve specific tests for such traits as the following:

(1) Speed of movement (whether a person naturally moves quickly or slowly), as shown by tests of handwriting.

(2) Freedom from load (the tendency to warm up rapidly and work at high speed without external pressure) as shown by a series of tests of handwriting.

(3) Flexibility (ease and effectiveness in readjustment or adaptability) as shown by ability to modify writing according to oral instruction.

(4) Speed of decision, as shown by speed of checking words "which describe *you.*"

(5) Motor impulsion (impetuosity and energy of reaction) as shown by tests of writing under various forms of distraction.

(6) Reaction to contradiction (the degree of confidence with which one maintains his opinion against contradiction).

(7) Resistance to opposition (the tendency to overcome obstruction) as shown when one's writing is interfered with during a test.

(8) Finality of judgment (whether one wavers or perseveres in his opinions) as shown by the tendency to change judgments expressed in an earlier test.

(9) Motor inhibition (a test of "motor control, imperturbability and patience") as shown by ability to write more and more slowly in a series of tests.

(10) Interest in detail, as shown by ability to copy writing specimens exactly.

(11) Coördination of impulses ("capacity to handle a complex situation successfully without forgetting any of the factors involved") as shown by ability to follow a series of requirements concerning a handwriting test.

(12) Volitional perseveration ("willingness to keep plugging away").

Downey's method is to use the scores for each test independently, displaying them for purposes of comparison in a graph which portrays the "will-temperament profile." Figure 50 gives a sample profile. A balanced or typical profile running from scores 4 to 6, according to Downey, suggests a less speedy, forceful, and accurate individual, that is to say, a more ordinary or average

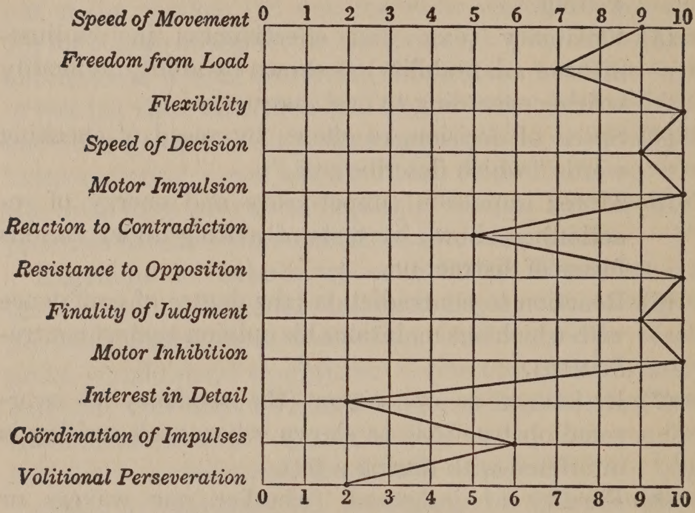

Fig. 50.—The Will-Temperament Profile of an Adult Who "Has Held a Number of Important Executive Positions. He is, in addition, an effective speaker and possesses great dramatic talent. His profile suggests, in general, the type of the successful administrator, especially with reference to the high scores for speed of decision, finality of judgment, freedom from load, resistance to opposition and motor impulsion in conjunction with high motor inhibition. The high score for flexibility and the medium one on reaction to contradiction (tactful response) indicate social pliability and suggestibility which increase X's social assets, but are of dubious value in his business life. The low score on interest in detail is not a serious defect, since X is in a position to turn over to subordinates the execution of many of his projects. It goes, however, with a tendency to generalize on insufficient grounds. The low score on volitional perseveration is probably a real weakness." (Graph and Quotation from Downey. *Manual of Directions*, copyright 1921, published by the World Book Company.)

profile, than one ranging from 8 to 10. High scores on such traits as speed of movement and decision, freedom from load, flexibility and motor impulsion are said to characterize an individual as mobile or rapid-fire in organization, whereas high scores in motor inhibition, interest in detail, coördination of impulses and volitional perseveration are characteristic of the controlled, deliberate, painstaking person. Many combinations are possible among the twelve tests, but they are not so numerous as to exaggerate the multiplicity of temperaments found in human nature.

Extensive study of the Downey tests, and others of similar character, have shown the procedure to be promising but in need of extension. Speed of reaction in general is not fully enough indicated by the speed of writing, alone; resistance to opposition, in general, is not adequately revealed by measuring a person's tendency to overcome the inference with the task of writing produced by the examiner in this test. It is necessary to test other samples of speed as in speaking, solving problems, tapping with the hands or feet, sorting colored balls, etc. Resistance to opposition is also specialized and varies with the situation. But just as intelligence or memory may be gauged sufficiently well for many practical purposes by a variety of tests, so, it appears, may the volitional and temperamental traits be measured. It is necessary only to provide more tests, each representing a real but specific situation in which the tendency may express itself and then, to secure a composite or average score. Although it will require numerous tests and considerable time to secure valid results, measurement of personality traits seems feasible.

Reactions to Typical, Lifelike Situations.—While the artificial, laboratory situation has the advantage of making possible a standardized procedure and rigid control it has the disadvantage of being often less typical of real life. Many investigators have tried to select situations from real life which could be satisfactorily controlled and thereby secure the advantages of both methods. Certain recent work in measuring honesty or trustworthiness or, to give the other extreme, dishonesty or deception (by May and Hartshorne) illustrates the plan.

These investigators have tried out a large number of tests based upon typical situations in the lives of children in the classroom, the school yard and the home, which provide an opportunity to cheat, steal, lie or otherwise practice deception. One test, for example, consists in giving the pupils a regular classroom examination on each of three days. On the third day, only, the pupils are given an answer sheet and permitted to score their own papers. They have no reason to suspect that these three examinations have been so carefully studied that when the examiner knows their honest achievements on the first two, he can predict very closely the honest score obtainable on the third. A big increase in the score indicates dishonesty—and such telltale jumps were by no means few among thousands of children tested.

Another series of tests depends upon deception in the form of "peeping" in order to make a better showing in a party game, or in a school test or in some other ordinary situation. In one test, for example, the child while blindfolded is supposed to pin a tail on a donkey as in the familiar parlor game. The blindfold, placed on the child who is supposed not to use his eyes even if he can, has a craftily arranged peephole. Since careful experiments have shown what such children can do when fully blindfolded, it is possible to determine the degree of probability which exists that a child peeps during the test. Other tests provide the pupil with opportunity of keeping without apparent means of being detected some of a number of coins given for some definite purpose such as solving a crisscross puzzle. Other situations afford opportunities to fake an increase in a score in jumping, "chinning," and other gymnasium and athletic events.

The series of tests is based on the assumption that a fairly reliable indication of a person's tendency to honest or dishonest behavior may be gained by testing him, without arousing his suspicion, in a number of different but realistic situations. The assumption seems to be sound. The tests do reveal deception and in a degree that correlates fairly closely with the facts brought out by careful study of the child's history by other more laborious means.

Summary and Conclusions.—We have listed samples of various methods of attempting to measure representative personality traits. Although certain forms of attack, such as the use of association tests, are by no means new, the problems are so complex that few instruments are yet developed to an entirely satisfactory state of precision. The outlook, however, is full of promise. Recent work, especially, based on a clear idea of the nature of various traits of the dynamic personality, has been so successful as to create assurances that most, if not all, important phases of personality may be measured. As the validity of the objective tests are demonstrated, the rôle of mental, emotional, temperamental, social, volitional and moral aspects of human conduct in contributing to individuality, in modifying achievement, in influencing adjustments to life generally will be more perfectly determined.

CORRELATIONS OF PERSONALITY TRAITS

By the use of such tests as these along with tests of intelligence and other capacities and acquired abilities, certain useful facts have been revealed concerning the way various abilities and capacities are combined in the case of typical and unusual personalities. Let us first consider the relations of various traits in typical cases.

Use of Correlations.—The method of correlation, first mentioned in Chapter III, has been extensively used to determine the way in which different traits tend typically to be related to each other. This technique makes it possible to show to what extent an individual's status in one trait corresponds to his relative position in other traits. Positive correlation means close correspondence among the abilities compared; zero correlation means that traits are entirely independent of each other; and negative correlation means that a high status in one trait goes with low standings in others.

Theory of Negative Correlation or Compensation.—A theory which has enjoyed popularity is, that a personality reveals a series of strengths and weakness, each being a compensation for the other. It has been asserted, for example, that a good memory stands opposed to good reasoning; that high musical talent is likely to go with unstable temperament; that scholarly minds are usually incased in frail and clumsy bodies; that strong bodies inherit weak wills; that great artists are prone to have inferior character. The theory is, in general, that the possession of great strength in one trait implies a corresponding weakness in some other trait.

Theory of Positive Correlation.—To the extent that various desirable personality traits have been measured, the facts usually favor the theory of positive correlation rather than that of negative correlation or compensation. The general tendency is for all types of desirable traits to show some degree of positive association. *Negative correlations among desirable traits are very rare.* The general fact is that weakness in one trait implies weakness in others; mediocrity in one trait implies mediocrity in others; and strength in one, strength in others. The fact that there is a general tendency toward positive rather than negative correlations does not mean that the correlations among desirable traits are always high or always equal. For example, intelligence is highly correlated with ability to learn; it is also substantially correlated with vocational abilities in general, and positively, but less closely related to musical, artistic, mechanical and locomotor abilities and aptitudes. The correlation of intelligence with various desirable social, character, volitional and temperamental reaction tendencies is, as far as we know, positive but of moderate magnitude. Superiority in general mental ability is correlated positively but not closely even with desirable physical traits. If we take a large group of individuals of the same age and divide them into two groups on the basis of intelligence, we shall find that the brighter group, as a whole, is somewhat superior in height, nutrition, sensory and motor efficiency, in resistance to disease, drugs, malnutrition, exposure, etc., and in other respects.

General mental ability, then, is positively associated more or less with other desirable traits. If the problem had been taken up from another point of view, such as the correlations of other traits with morality or artistic ability, the same *general* result would have been found, namely, all desirable traits tend to be associated with each other. The correlations are not equal, however, and they are often low. Even a correlation as high as $+0.90$ permits several individuals fairly high in one trait to be fairly low in the other, and vice versa. Specialization there is; we all have our particular strengths and weaknesses. But on the average, weakness in one trait implies weakness in others; mediocrity in one implies mediocrity in others, and strength in one, strength in others.

The fact that desirable traits are positively related must not lead us to conclude that *any particular person* who is high in one trait is necessarily about equally high in others. The tendency toward positive correlation is so slight as to hold only in general or in the long run. This general trend does not preclude the possibility that individual personalities may fall into a small number of characteristic patterns of traits, nor does it imply that it is impossible for personalities to reveal an almost unlimited number of different combinations. These two possibilities we shall therefore consider next.

PERSONALITY TYPES

Use and Misuse of the Notion of Personality Types.— There always has been and still is a tendency to try to classify all individuals into a small number of classes or types. The traditional types of temperament, for example, the sanguine, or animated and cheerful; the melancholic or depressed; the choleric or quick, high-strung, easily provoked; and the phlegmatic or slow and calm, are often preserved under new names and frequently other varieties added, but a disposition has remained to reduce all to a relatively small number of types. By this procedure, two errors are likely to be encountered. The first is the erroneous notion that individuals fall into several rather discrete groups, that individuals tend to be at one or another extreme. This is quite untrue; in sanguineness or any other such characteristic, individuals vary continuously from one extreme to the other, with the largest number clustered midway. In all these traits, in other words, individuals are distributed more nearly in accordance with the normal curve than in accordance with a curve thinly populated in the middle as compared to the extremes.

Most individuals are neither conspicuously irascible nor calm, buoyant nor depressed, self-assertive nor submissive, introvert nor extravert, but nearer the average than these extremes. The extremes, then, are not "types" in the sense of being the most typical of the whole group. On the contrary they are numerically least typical. The most representative individual is the average.

Each Personality Possesses Individuality.—The tendency to group people into a small number of types has resulted in another misconception, namely, the idea that the range of individuality is not wide—that many personalities are, in most practical respects, substantially the same. This view is incorrect for two reasons: the number of traits in which individuals differ is large and the possible combinations of varying amounts of these traits found in particular individuals are almost innumerable. The probability that any two persons are alike in every respect is almost nil. Every person is unique; every personality possesses individuality. From every person who exists during your lifetime, you are likely to differ not only in one but in many respects. The pattern or configuration or integration of your traits is distinctive. Even if two persons should differ only in the degree to which they possessed one trait, they might differ greatly as a whole in many practical respects. To have a little more health, or aggressiveness or intelligence than another whom you equal in all other respects might make a profound difference in your whole life and personality development. A difference in a single respect may influence the potency of many or even every other trait. To evaluate a personality we must appraise the entire pattern or combination of characters.

The Number of Personality Types.—The varieties of combinations of traits which are found in individuals are so numerous as to make impossible even a rough grouping of "types." Most of our current analyses of personalities are oversimplification of the facts. We can illustrate, however, the far-reaching effects upon the total personality and life of small differences in a few traits by discussing certain outstanding and easily identifiable grouping of individuals.

Sex Differences.—If an attempt were made to divide the human race into types of personalities, no grouping could be more obvious and, if popular opinion were reliable, no groups more conspicuously different than male and female. In fiction and in pseudo-scientific literature, sex differences are described in number and degree so great as to make man and woman appear to be members of nearly distinct species. This is doubtless due in part to a tendency to compare extreme cases of the two groups. It may be said at the outset that while sex differences do exist, they are less great in particular traits and in fewer respects than has generally been supposed. Before considering male and female personalities as a whole, it will be necessary to consider the differences in specific traits. In gross physical traits—height, contour, weight, strength and appearance—sex differences are most spectacular, a fact which doubtless has had an influence on the judgments of mental and temperamental traits. But even in physical traits, the overlapping of boys and girls of the same age, or of men and women, is considerable.

In general intelligence sex differences are *less* conspicuous than physical differences at all stages of growth, as is shown by many studies of children of all ages and adults with intelligence tests. Studies (by Terman and Burt) have shown that girls from ages six to fifteen years surpass the boys on the average by about three-tenths of a year in mental age, but the superiority is irregularly distributed. It has been customary to see in these figures a more rapid mental maturation of girls to harmonize with their more precocious physical development, but even if this interpretation is correct—it is not altogether certain that it is—the significant matter is the closeness of the approximation of the two sexes to equality. As adults they are equal.

In more specific mental abilities—perception, memory, reason, etc.—the differences between the sexes, where they exist at all, are so slight and unobtrusive as to be swamped by comparison with the immensity of the variation within either sex.

In special aptitudes for various types of school work, sex differences again appear to be slight. Using a battery of standardized tests for reading, vocabulary, arithmetic, spelling, composition, writing, drawing and handwork, Burt has measured over 5000 school children in 19 different schools, yielding for each age approximately 750 representatives of each sex. The facts are given in the accompanying table which displays the relative attainments of each. On the whole, the differences are essentially negligible. Girls excel slightly in reading, spelling, writing and composition; boys in arithmetic and handwork; in drawing the sexes are equal. How insignificant are the differences in general is disclosed by the data for arithmetic. In addition girls are slightly superior, in subtraction boys excel, in multiplication attainments are equal, and in division boys excel slightly. All through the list, the sexes play a veritable leapfrog with each other and even in handwork the differences are so small as to be statistically unreliable. On the whole, with equal incentives there is little justification for the assumption of sex differences in capacities for achievement in school functions.

The Average Scores for Boys and Girls of the Same Average Age
(From Burt)

	Reading Speed (Seconds)	Reading Comprehension Questions Answered	Spelling Words Correct	Addition Number Correct	Subtraction Number Correct	Multiplication Number Correct
Boys.......	117*	11.3	53.6	21.1	41.0	40.7
Girls.......	112*	11.6	56.4	21.4	39.7	40.9

	Division Number Correct	Writing Letters in Two Minutes	Writing Quality	Drawing Quality	Handwork Speed (Seconds)	Handwork Quality	Composition Quality
Boys.......	29.9	117.2	9.8	10.0	54.6*	10.8	10.6
Girls.......	29.1	125.2	10.1	9.9	55.7*	10.2	11.4

* Scores are given in terms of seconds—the smaller figure therefore indicates the better performance.

Concerning sex differences in volitional, temperamental, moral and other traits innumerable opinions have been given; but for none is there unquestionable evidence. Indeed, as more precise measurement becomes possible the verdict of "no significant difference" is most frequently cast, although it may be that in the traits as yet unmeasured important differences will be disclosed. The most probable differences are certain attitudes and emotional propensities clustering around the differences in the reproductive functions on the one hand, and the differences in physical powers on the other. It is believed by some, but not proved, that the maternal urges differ in strength and in operation from the paternal, resulting for the woman in a keener interest, broader sympathies, and perhaps clearer insight in dealing with human expressions and acts. Men may be more self-assertive and pugnacious, in keeping with their superior physical strength, but these facts are not yet clearly demonstrated.

Differences in general achievement and personality between the sexes, then, in so far as environmental influences affect them equally, are doubtless exaggerated by the tendency to compare the extremes rather than the typical cases. The general differences which do obtain are to be explained not so much by differences in all single traits as by the influence of a few which color the whole. Thus, if the parental urges are stronger in women, it may affect widely their activities in and relations to life. The superior physical strength of men—and if genuine, the greater force of the pugnacious urges—would account in part for their greater achievements, even if the mental and motor aptitudes of the sexes were equal.

Racial Differences.—Another opportunity to study combinations of traits is provided by the existence of different races. Indeed, it is and always has been customary to believe that each race has its peculiarly individual personality; that the Frenchman, Englishman, German or Swede is innately organized in a characteristic way; in a pattern that cannot be wholly rearranged by environment or training.

Among civilized races differences in physical traits are demonstrated; differences in temperamental traits are probable, but not demonstrated; and differences in mentality are neither demonstrated nor probable. Extensive measures by various forms of the Binet test in France, Germany, Sweden, England and America, and less extensive investigation in other countries, show inconspicuous variations in general outcome. The probability is that the general mental ability of these races is approximately equal. In America, little has been learned of racial differences, except that on such tests as the Army Alpha, Negroes and Indians perform relatively poorly; but any sweeping statement of the intellectual status of these races would be premature. Among other races in America, in so far as traits have been measured, the overlapping is very great, both in physical and mental characteristics. Concerning temperamental, volitional and character traits, there is little to offer except conjecture. It is quite likely, however, that the tendency to seize upon some one or few peculiarities of a race, magnify them and judge the whole personality in the light of them, results in an exaggeration of the differences between races. The fact that races differ when we consider their personality as a whole does not prove that they differ greatly in all or even many particular traits. While slight differences in a few traits may profoundly influence the whole pattern, among the more advanced races, practically no native differences have been demonstrated.

Summary.—Individuals differ widely in all traits that have been measured. Since individual differences in characteristics which have been objectively determined tend to conform to the surface of frequency known as the Normal Surface or Curve, it is reasonable to assume that variations in all other traits will take the same form. Since the Normal Curve shows most persons clustering near the average of the group in any trait rather than at the extremes of the distribution, the "typical" person is an average one; the average or mediocre person is the *type*. The possible combinations of the many traits in which persons differ are so great that no two are likely ever to be alike. Every personality possesses individuality. The pattern or combination of traits for each person is unique. Even persons—such as the average male or female, or representatives of different races,—who demonstrably differ only slightly in few respects nevertheless present very different total personalities and achievements.

THE ORGANIZATION OF PERSONALITY

The fact that all individuals cannot be classified into a small number of distinctive personality types should not lead us to think that *each* personality is a disorganized and unpredictable collection of reactions. We may be very different and yet each of us may be consistently what *he is*. Individuality does not mean disorganization. Personalities are unique because they represent a large number of traits differently organized. In this final section we shall consider some of the characteristics of organization revealed by typical and abnormal personalities. From these facts we may secure some suggestions concerning the desirable and undesirable tendencies in the development of a personality.

Characteristics of Personality Organization.—To begin with, it may be said that the typical or average person reveals in his behavior a considerable measure of

1. Unity or Integration
2. Consistency
3. Continuity and Persistency
4. Coördination and Flexibility

Suggestions for improving the personality as a whole must take into account these characteristics as well as the principles of learning treated previously in this volume.

Unity of the Self or Personality.—The sound personality comprises reaction tendencies that are not loosely organized but closely related, or integrated. Study of the personality from the introspective point of view reveals this unity in the form of what is often termed the primary or dominant *self*. Every one recognizes a central something which is one's innermost, characteristic *self*. This self, which you have identified since childhood, has certain characteristics which make it unmistakably *your* self. It has a characteristic unity. Analyze this self and you will find that it comprises memories, thoughts, feelings, emotions and especially desires, aspirations and purposes. By most psychologists the self is regarded not as an agency apart from, or superimposed on these conscious experiences but these experiences themselves in organized form. The idea that the self is a special agency is attributed to the fact that the more characteristic and the more enduring of our reaction tendencies—memories, feelings, emotions, desires, purposes—tend to be welded together into a unity. This unity tends to endure; it results in certain persisting reaction tendencies and in a certain consistency in behavior.

Consistency of Reaction Tendencies.—The facts are illustrated by familiar experiences. When, for example, as the result of a fit of anger, sickness, or shock, deviations from one's normal behavior occur, one may immediately explain: "I was not myself, at all; I was all upset." Our behavior—the basis on which others judge our personality—tends also to possess definite characteristics and consistency. Friends who observe our exceptional behavior may agree: "No, you were certainly not yourself." The typical thing, then, is a certain degree of consistency in our tendencies to react. The *self* and the *personality* both reveal the same integrated and consistent character of our reaction tendencies; they are the same facts viewed from two different standpoints, the subjective and objective.

Continuity of the Self and Personality.—While one's behavior tends to run more or less true to form, the personality and self are subject to change. From birth to death, modifications are constantly occurring. Personalities typical of childhood, adolescence and other periods are recognized despite the range of individual differences. Yet the changes show, usually, a continuity. Abrupt changes, which may occur as the result of religious conversion, illness, exceptionally good or bad fortune, are exceptions rather than the rule. Always possessing a certain unity in the typical cases, the personality shows gradual reorganization rather than a series of abrupt reconstructions. Although gradually changing during long periods of time, the personality usually possesses a continuity of pattern which makes possible a certain consistency in reaction which the subject and those familiar with him recognize and depend upon.

Flexibility and Inflexibility of Personalities.—A personality may be well integrated and yet flexible. The integrated, *inflexible* personality is one which is always the same. It is organized in one system of reaction tendencies as illustrated, for example, by a person who is always very serious, always interested primarily in one topic and activity, always active chiefly along one line. This rigid, fixed personality contrasts with the average person who, as he develops from childhood, acquires several selves in the form of systems of reaction tendencies. He may develop simultaneously a playful, carefree, witty, friendly self; a serious, precise, apprehensive, thrifty, business self; a humble, benevolent, submissive, religious self; and an expansive, boastful but kindly and generous family self. He may be flexible in the sense that he can shift from one personality to another as a response to the situation or deliberately change to satisfy his own desire to round out his daily life. In this case, the several selves may not conflict with, but supplement, each other. They represent not dissociation but a flexible type of integration. They are integrated and subordinate to certain more dominant trends. Such flexibility is desirable when it is based upon several supplementary systems of reaction which are properly coördinated and subordinated to socially approved, dominant purposes.

Coördinating and Conflicting Trends.—A matter of vital importance in the development of personality is the way in which various subordinate organizations of reaction tendencies are related to each other. In Chapters VI and VII we discovered that we are subject to diverse desires. We desire to work and to play, we wish to secure social approval and also to accumulate goods; we experience urges to be kindly and also to be masterful. In particular situations these desires may be conflicting. Healthy growth requires that the various native and acquired trends be coördinated and harmonized instead of being permitted to develop into conflicting systems. The disastrous effects of persisting conflicts between one's "better" and "worse" self, or between the family and social self were pointed out in Chapter VII. Continued conflict is so intolerable that it drives the person to find some solution. The rigid, stiff, inflexible personality is one unwholesome solution. Another solution is an *uncoördinated* personality which in the extreme case becomes a split or dissociated personality like Dr. Jekyll and Mr. Hyde in Stevenson's classic story.

Dissociated or Alternating Personalities.—A few cases of completely split or dissociated personalities which are often called *double* or *multiple personalities* have been reported. According to these reports, a split personality shows the individual alternating between two (or more) selves, one of which is usually more lasting and therefore called primary. One personality is usually more like the dominant self prior to the dissociation. The alternating personalities may be very different; one vivacious, jovial, competent and kindly, the other stolid, irascible, careless and mischievous. One self may know nothing about the other personality from which it differs so greatly. One personality may recall what the other had been doing but think of these actions as those of another person. The individual thus seems to be dissociated into two personalities which have been torn apart so that each functions independently. In rare cases, the personality inactive at the moment is reported as being in the background and observing what the other unsuspecting personality does, but is unable to influence the activities of the temporarily active self. The two personalities in all these cases are separate selves, though occupying the same body. Though one may be better organized and in control for longer periods than the other, the two do not work together or influence each other. They are not, like the several business, social and other selves of the normal person, subordinate to more dominant trends. The parts are not integrated; the individual functions not as a whole but in isolated parts.

Integrating and Balancing the Personality.—While we cannot as yet either describe or explain these strange cases of dissociation, we can at least say that they are rare and unwholesome means of solving conflicts between antagonistic reaction tendencies. Conflicts among tendencies we all shall experience. What we must do is to develop systems of reactions around certain dominant trends in such a way as to enable us to realize a relatively full life without continual clash among the subordinate tendencies. One's life must be guided by certain dominant purposes, preferably those which represent productive activity of a socially approved type. A person's interests and activities must be varied sufficiently, however, both to meet the needs of the world in which he lives and to satisfy in some fashion the fundamental cravings of human nature. To have merely an interest in and to establish only habits related to the attainment of vocational success is likely to prove unsatisfactory. It is a rare vocation which enables a typical person to round out a completely wholesome personality without the supplementation of various home, social, recreational, religious, artistic or other interests and activities. Systems of habits need to be established in several fields. To develop an admirable personality the various interests and habits must be so selected and coördinated as to supplement rather than contradict each other; they must be harnessed so they may pull together, rather than contrariwise, to further the dominant trends. When properly integrated with the dominant trends they give the personality flexibility without conflict. Such an integration requires careful study of one's nature, one's environment and one's major activities. Integration and harmony are achieved by selecting among conflicting impulses those which serve best the interests of the individual and society as a whole, by coördinating the reaction tendencies selected and by providing satisfactory substitutes for impulses denied, along the lines laid down in Chapters VII and VIII.

Personality Development a Gradual Process of Consistent Habit Formation.—A well-balanced and integrated personality can result only from a gradual process of consistent habit formation. A happy and efficient self is the result of eternal vigilance on part of pupil and teacher. We may conclude our long study, which has been mainly an elaboration of this statement, with a passage from William James:

> "The hell to be endured hereafter, of which theology tells, is no worse than the hell we make for ourselves in this world by habitually fashioning our characters in the wrong way. Could the young but realize how soon they will become mere walking bundles of habits, they would give more heed to their conduct while in the plastic state. We are spinning our own fates, good or evil, and never to be undone. Every smallest stroke of virtue or of vice leaves its never so little scar. The drunken Rip Van Winkle, in Jefferson's play, excuses himself for every fresh dereliction by saying, I won't count this time.

Well, he may not count it, and a kind Heaven may not count it: but it is being counted none the less. Down among nerve-cells and fibres the molecules are counting it, registering and storing it up to be used against him when the next temptation comes. Nothing we ever do is, in strict scientific literalness, wiped out. Of course, this has its good side as well as its bad one. As we become permanent drunkards by so many separate drinks, so we become saints in the moral, and authorities and experts in the practical and scientific spheres, by so many separate acts and hours of work."

QUESTIONS AND EXERCISES

1. Secure school report cards, employers' reference cards, etc., and tabulate and compare the personality traits mentioned. Criticize these as outlines of personality. Criticize the outline offered in the text.

2. Among your acquaintances, do desirable traits seem to go together? Try this out by rating them in several traits such as intelligence, personal appearance, health, popularity, and trustworthiness. Do the persons who rank high in one trait tend to rank above, at, or below the average in others?

3. To what practical uses, in education or elsewhere, may the facts of correlation among desirable traits be put? Do they make more or less significant the results of tests of intelligence? Explain.

4. What do people usually mean when they speak of a "womanly woman," "a manly man," "a true Irishman," "a typical Frenchman"? Do you know any such individuals?

5. Define exactly what is meant when you describe another individual as having "a good personality," in terms of specific instincts, capacities, and acquired traits.

6. Why do we have less accurate measures for such traits as diligence, ambition, etc., than we have for intelligence? Are these traits more complex, intrinsically more difficult to measure, less important in life, or are there other causes? Draw up a list of possible explanations.

7. Have women accomplished as much as men in the fields of art, literature or science? How do you account for any discrepancies found? What biological and environmental as well as psychological factors might be important?

8. To what extent do the facts given in the chapter suggest the need of separate schools or classes or subjects of instruction for boys and girls?

9. What considerations other than capacities should be taken into account in debating the need of specialization of subject matter for the two sexes?

10. Which will usually tell you most about an individual's mental equipment, a knowledge of his race or a knowledge of the traits of his parents?

11. Draw a curve of distribution which will show how we distort the facts when we assume that individuals are divided into types.

12. What traits, other than those mentioned in the text, do you think may contribute to success in school work or life? What ones to desirable moral adjustments? To musical ability? To dramatic ability? To executive ability?

13. Compare an individual who is near the maximum degree of consistency in his behavior with others of less consistency. Which ones, other things equal, would you prefer for a boss, playmate, husband or wife, employee, etc.?

14. Compare, similarly, the personality of a person who has several systems or constellations of habits with one who is merely unorganized and inconsistent and also with one who is "always the same."

15. How does one's idea of his *self* develop in infancy and childhood? Is the child born with a notion of himself as distinguished from other persons or things? What, probably, is the influence of perception, memory, dreaming, etc., in the development of the idea of one's self?

16. What forms of adjustment, mentioned in Chapter VII, might be responsible for the development of a double personality?

17. What school subjects or activities are especially useful for developing desirable traits of character and temperament? How do the facts presented under *transfer of training* bear upon this question?

18. What are the differences, if any, between temperamental and volitional traits?

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